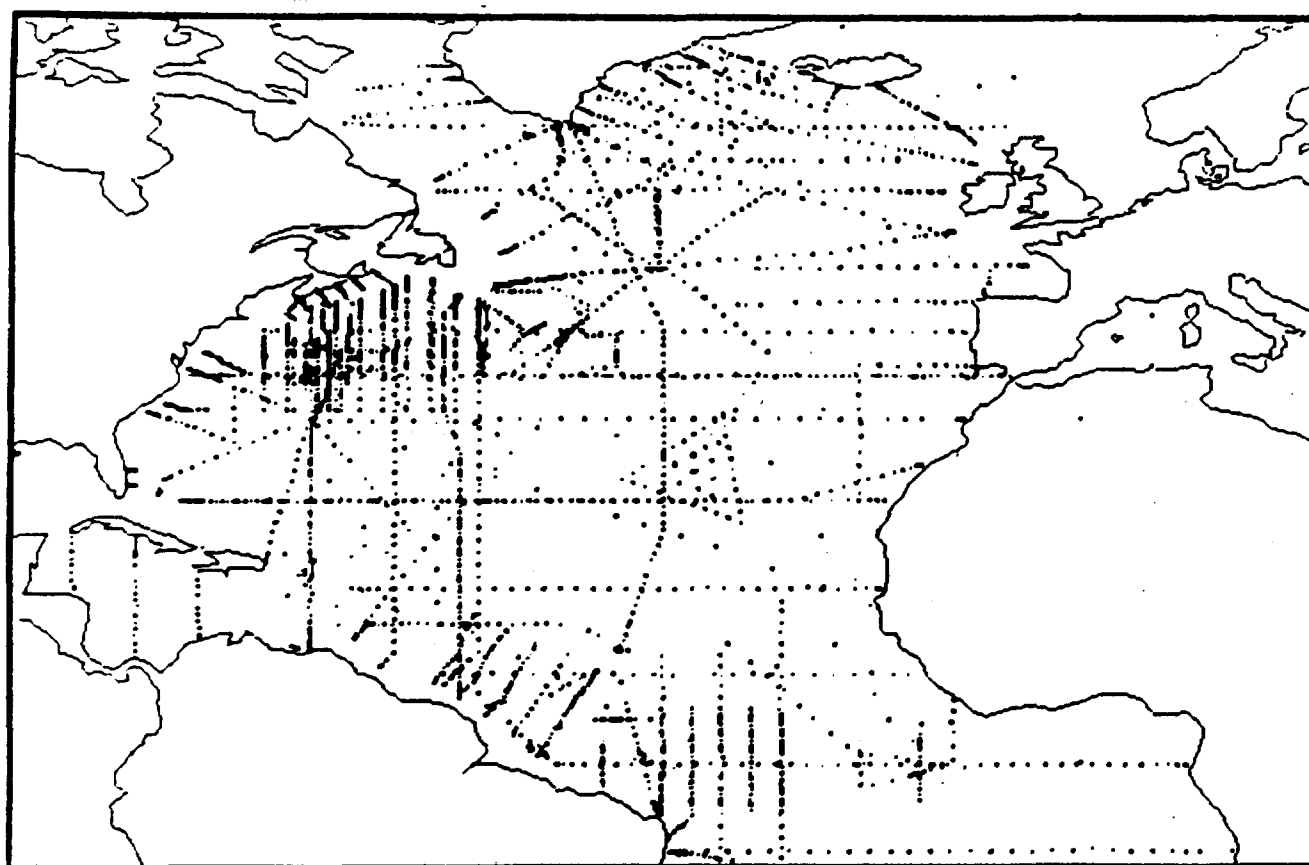


Exploring the North Atlantic Ocean on Floppy Disks



James R. Luyten
and
Henry M. Stommel

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

December, 1988

Technical Report

DTIC
ELECTE
MAR 23 1989
S H D

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited

89 3 20 125

WHOI-88-59

Exploring the North Atlantic Ocean on Floppy Disks

by

James R. Luyten
and
Henry M. Stommel

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

December 1988

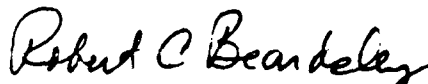
Technical Report

Funding was provided by the Office of Naval Research
under contract Number N00014-84-C-0134,
and the National Science Foundation
through grant Number OCE86-13810.

Reproduction in whole or in part is permitted for any purpose of the
United States Government. This report should be cited as:
Woods Hole Oceanog. Inst. Tech. Rept., WHOI-88-59.

Approved for publication; distribution unlimited.

Approved for Distribution:



Robert C. Beardsley, Chairman
Department of Physical Oceanography

Table of Contents

	Page
List of Figures and Table	5
Abstract	7
1. The Files and Utility Programs on the Disks	7
2. A First Cruise	8
3. A Cruise at Higher Latitude	12
4. Some North-South Cruises from Disk NA-1	13
5. Making Maps	14
6. Anomalies True and False	19
7. Utility Program Logic and Description	21
MAKER.BAS	22
READER.BAS	23
PLOTTER.BAS	25
AUTO PLOT.BAS	29
MINIFILE.BAS	31
FASTSCAN.BAS	33
Appendix 1. Graphics, BASIC Interpreters and Compilers	37
Appendix 2. Program Listings	38
MAKER.BAS	38
READER.BAS	39
PLOTTER.BAS	40
AUTO PLOT.BAS	42
MINIFILE.BAS	46
FASTSCAN.BAS	48
POTEMP.BAS	51
Appendix 3. Directory of the Atlantic Disks	52
Acknowledgements	54
References	54

List of Figures

	Page
1. Positions of stations on Disk NA-1	57
2. Positions of stations on Disk NA-2	59
3. Positions of stations on Disk NA-3	61
4. Positions of stations on Disk NA-4	63
5. Sketch of screen for PLOTTER	65

Table

I. Identification of Cruise Data Files	55
--	----

The disk for this report can be obtained from:
 Woods Hole Oceanographic Institution, Woods
 Hole, MA 02543
 Per Ms. Susan Putnam, WHOI/Document Library

Accession For	
NTIS (P&I)	<input checked="" type="checkbox"/>
DTIC (P&I)	<input type="checkbox"/>
Unpublished	<input type="checkbox"/>
per telecon	
Av. 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, 1000	
Dist	
A-1	

Abstract

A selection of hydrographic station data in the Atlantic between 8°S and 70°N is packed on four 5 $\frac{1}{4}$ " floppy disks. Sample utility programs for reading and plotting the data are also on the disks. We present this computer atlas in preliminary form for use by students and professionals, in the belief that easy access to this valuable historical data will be educational and stimulating. Criticism and comment are welcome.

1. The Files and Utility Programs on the Disks

In the past oceanographers of the Atlantic, G. Dietrich, F. Fuglister, C. Iselin, C. Mann, W. Metcalf, J. Swallow, L. Worthington, G. Wüst, developed their knowledge of the geographical distribution of observed properties in the ocean by plotting up hydrographic station data while it was actually being gathered at sea. The experience can be partly simulated by replaying oceanographic cruises on a personal computer. Because the simulation is greatly accelerated [perhaps 10,000 times] over the rate of accumulation of data from a real cruise, the impact of the tedium is less, but on the other hand the cruise can be replayed many times, and of course many more cruises experimented upon.

A selection of files of modern hydrographic station data in the North Atlantic has been stored on four floppy disks. The cruises used are listed in Table I. In Table I there are three designations for each cruise file. In the first column is a sequential number N for the cruise files on the disks. In the second column there is C\$(N), the name of the file as given by NODC. In the third column there is a name D\$(N) that is more mnemonically significant. The locations of the cruises are indicated in Figures 1-4, one for each disk.

Cruises are usually made for specific reasons, so there is no general scheme or uniformity of plan according to which they are laid out geographically. Disk NA-1 has mostly north-south sections; Disk NA-2 has mostly east-west cruises. Most of the cruises on Disks NA-3 and NA-4 are rather irregular tracks, not convenient for drawing sections, but useful in widening the geographical coverage. Each cruise has a complete file of hydrographic data.

In addition to cruise data the disks also include some utility programs in Microsoft GW-BASIC Version 2.01, suitable for IBM compatible personal computers. [They also contain a short file called MAP.FIL that is used to draw a map of the North Atlantic from 10S to 70N]. When using these disks you must first load a copy of BASIC (BASICA for IBM machines). The instructions in this report are written with the assumption that the machine has two drives A and B, that you use the disks in Drive B, and other extra disks in Drive A. Modifications needed for other machines and for use with a hard disk are discussed in Appendix 1.

The disks contain the following utility programs:

MAKER.BAS	Disk NA-1 only
READER.BAS	all disks
PLOTTER.BAS	all disks
PLOTTER1.BAS	Disk NA-3 only
PLOTTER3.BAS	"
PLOTTER9.BAS	"
AUTOPILOT.BAS	Disk NA-4 only
MINIFILE.BAS	"
FASTSCAN.BAS	"
POTEMP.BAS	"
%SATO2.BAS	"

The four disks are write-protected. Occasionally (with Disk NA-1 through NA-4 in Drive B) while using the utilities of Disk NA-4, it will be desirable to write a new file to a disk. In such cases it is convenient to use a freshly formatted fifth disk in Drive A to receive the new file. We will want to build up a series of personal files on this fifth ephemeral disk.

2. A First Cruise

The 1981 Atlantis II section on 36N. The best way to learn how to get data from the disks, how to plot it up meaningfully, and to experience a sense of discovery, is to take a simulated cruise. [Of course it is even better, but more strenuous and time-consuming, to take a real cruise]. So we will begin by choosing a recent [1981] Atlantis II section on which Dr. C. Wunsch was Chief Scientist. It extended from off Chesapeake Bay to Spain. The data was made by modern CTD instrumentation, not Nansen bottles as is much of the older data that we still rely upon.

As indicated in Table I, this cruise is to be found on Disk NA-2 in a file entitled "24-36n". This file contains two sections, one at 24N another at 36N and two sections across the Florida Straits. Before we do anything else, we have to discover how to separate these portions of the data in the file. So we must read the file to select those portions of it that we want to use.

Put Disk NA-2 in Drive B. Load B:READER and try a few values of REC [REC stands for a sequential record number for each line of data in the file]. If you try REC=1 then you will find that the data is from the 24N section. After a little experimentation you will find that REC=2850 starts you at the beginning of the 36N section off Chesapeake Bay. So jot down this number.

Now load B:PLOTTER, then RUN, input "24-36n", RETURN, and a grid of coordinates, much like that in Figure 5, appears. When the map of the coastline of the North Atlantic is completed, there will be a few noises from the drive, and then the machine asks for the REC. Enter the value for the beginning of the 36N section that we just found: 2850, and RETURN.

We are now launched upon the cruise. On the map we see that the ship track appears off Chesapeake Bay, moving SE toward deep water and the Gulf Stream. To the left of the map there is a grid for drawing a section of properties. The lines are spaced 10 degrees of longitude apart, and every 1000 decibars of pressure in the vertical. The colored spots that appear are actual data points, uncontaminated by interpolation. The colors assigned to these points depend upon the value of some observed variable, such as temperature, salinity, etc. The default variable is temperature with colors changing every 5 degrees centigrade.

The version of PLOTTER.BAS on Disk NA-2 is suitable for the coarsest resolution color scheme [SCREEN 1 and only three colors]. If you have a more advanced machine that has seven or more colors and a higher resolution screen, then use an alternative form of PLOTTER found on Disk NA-3. If you can set SCREEN 3, then use PLOTTER3.BAS. If you can set SCREEN 9, then use PLOTTER9.BAS. These will give much nicer displays than plain PLOTTER.BAS or PLOTTER1.BAS.

The main problem in machine compatibility is in the graphics -- especially in the LOCATE statement, and in the assignment of colors. Fortunately the geometric distortion of the ratio of ordinate to abscissa that some monitors suffer from does not seriously affect our displays.

The default abscissa in this plot is longitude, because on Disk NA-2 most of the sections are east-west. The default ordinate is pressure [or effectively depth] positive downward. There are four panels along the bottom of the display, as shown in Figure 5, and they can be assigned to various types of display. The default ones are, going from left to right: pressure against temperature, temperature against salinity, oxygen against potential density [sigma-theta], and pressure against salinity. Of course these can be easily reassigned in the program.

Whenever we want to halt the ship, we just strike the SPACEBAR, a second strike starts us up again. Give it a try so that you can get your bearings.

As we move to deep water, we note the shallow thermocline and low surface salinities characteristic of Slope Water. By station 16 we have crossed the Gulf Stream, as indicated by the deepening of the thermocline and halocline, and the sudden sharpening of the S-T relation. We then turn eastward along 36N -- and this is rather close to the Gulf Stream just north of us. As a matter of fact in stations 25 to 27 we find ourselves unexpectedly passing through a cold eddy or loop extending southward from the Stream. By station 32 we are well south of the Stream again with a thick layer of 17-19C water -- in the Sargasso Sea. By station 55 this so-called Eighteen Degree Mode Water has thinned out and the thermocline is considerably shallower. We cross the top of the Mid-Atlantic Ridge at about station 61 -- a good place to pause by striking SPACEBAR.

Note that the salinities near 1000 decibars have risen -- this can be seen on both the S-T diagram and the S-P diagram. It is a result of larger

amounts of Mediterranean Water as we move eastward. Continue the cruise by pressing SPACEBAR once again, and notice that by station 82 as we approach Spain the Mediterranean influence reaches its maximum.

It is now a good idea to rerun the cruise, but this time while drawing a salinity section instead of a temperature section. For example, we can change some lines in the program as follows:

```
5200 IF S>34 THEN CLR=2: IF S>34.5 THEN CLR=3
5300 IF S>35 THEN CLR=4: IF S>35.5 THEN CLR=5
5400 IF S>36 THEN CLR=6: IF S>36.5 THEN CLR=7
```

The salinity section shows the wedge of Mediterranean Water effectively. An oxygen section can be drawn, for example by the rewriting of the lines

```
5200 IF O>3 THEN CLR=2:IF O>4 THEN CLR=3
5300 IF O>4 THEN CLR=4:IF O>5 THEN CLR=5
5400 IF O>6 THEN CLR=6:IF O>7 THEN CLR=7
```

The oxygen section at 36N shows lower oxygen in the deep water of the eastern basin of the North Atlantic than in the western basin. This is expected because the eastern basin is not directly ventilated from sinking water from polar regions, but only indirectly from the western basin by inflow from the western basin in the tropics. The lowest oxygens in this section are at the base of the thermocline in the western basin in the Sargasso Sea, a fact that seems at first somewhat odd, because from theoretical notions we expect shadow zones to be most extensive in the southeastern sides of subtropical gyres -- until we remember that there are also, perhaps, recirculating unventilated pools of the Rhines-Young variety at the western edges of gyres.

If, while retaking the cruise, you want to see oxygen as a function of pressure [depth] in the third panel along the bottom of the screen instead of the sigma-theta vs oxygen curve, then you can rewrite this line

```
6600 PSET(350+15*O,200+P*180/6000),CLA
```

If you are sufficiently interested, or have some dynamical ideas to test, then a section of sigma-theta or some other computed quantity may be to your taste.

Oceanographers are often more interested in rather subtle and small differences of the measured variables such as might be expected in the deep water in different basins. We can examine small differences of deep-water temperatures, for example, in a variety of ways. One way is to change the color values of temperature to achieve a more finely resolved temperature scale in the range where the differences occur. Using B:READER it is easy enough to establish the characteristic deep-water temperatures in the western and eastern basins at 36N. On the basis of such an examination we choose the following rewriting of some lines in B:PLOTTER

```

5200 IF T>2.2 THEN CLR=2: IF T>2.3 THEN CLR=3
5300 IF T>2.4 THEN CLR=4: IF T>2.5 THEN CLR=5
5400 IF T>2.6 THEN CLR=6: IF T>2.7 THEN CLR=7

```

Run this section and observe the difference in temperature of deep water on the two sides of the Mid-Atlantic Ridge from the difference in color.

Another way to see the difference is to expand that part of the screen with the T-P profile. We can achieve this by modifying the following lines in B:PLOTTER

```

1020 WINDOW SCREEN (50,250)-(75,400) 'sets frame
1200 LINE(58,350)-(62,350),1
2100 'GOSUB 10000:BEEP
6500 'PSET(200+50*(S-35),360-5*T),CLA

```

The purpose of the rewritten form of line 1020 is to enlarge that portion of the screen where the T-P profile is drawn. Line 1200 draws a line segment from 2C to 3C so that one can judge the temperature scale. Line 2100 disables the map drawing subroutine to save time. Line 6500 disables the plotting of the nearby S-T diagram so that outlying points won't stray into the picture of the T-P plot.

Now we redo the cruise once again and observe the magnified T-P plot. At station 6 we have gotten to a depth of 2000 decibars, and at station 13 to 4000 decibars -- as we descend the continental slope off Chesapeake Bay toward deep water. The minimum temperature here is at about 3600 decibars. Deeper temperatures are higher because of the adiabatic increase with pressure. By the time that we have arrived at station 36, we begin to pick up, at the bottom, traces of Antarctic Bottom Water that originates from the South Atlantic. These are at pressures greater than 5000 decibars.

At station 62, on the Mid-Atlantic Ridge, we discover an interesting pocket of water isolated by bottom topography. It has an adiabatic lapse rate [constant potential temperature] for a pressure interval of 800 decibars. We then descend into the eastern basin and find the deep water to be about 0.2C warmer than that in the western basin -- as we found before.

While we have this particular graphical set-up in the program, perhaps we ought to explore the contrasts between deep waters on the two sides of the Ridge at some different latitudes. If we enter, as before "24-36n", but this time start with REC=1, we will begin with a 1981 section across the Atlantic at 24N starting slightly north of this on the African continent. This deviation from a straight latitude was a bow to geopolitics, a factor that didn't seem to influence an earlier generation of oceanographers. Anyway, now we begin in the eastern basin. Some small oddities in the magnified T-P plot occur at stations 190-191, over the Ridge. By station 193 we are descending the Ridge into the western basin at a temperature somewhat colder than that in the western basin at 36N. Don't let the computer run too far, otherwise you'll find yourself in the Florida Straits or on 36N. It is even

more interesting to look at the situation on the 8S section, even closer to Antarctica. Enter "8s-8n", and REC = 302. We can't start at REC=1 without calling up a set of stations made as the R.V. Crawford sailed down to Loanda from Woods Hole. With REC=302 the cruise starts at the eastern end of the 8S section, and goes westward. At first we find the same familiar deep water of the eastern basin, but at station 110 we enter the western basin and discover extremely cold water below 4000 decibars, bounded from the water above by a form of front -- sometimes referred to as a "benthic" front. This cold water from the far south lies between 0.5C and 1.0C. Stop the cruise before station 154 (REC=1020) or you will find yourself back in the northern hemisphere at 8N.

3. A Cruise at Higher Latitude

We will now embark upon the first leg of a cruise made in 1962 by L. V. Worthington aboard the charter Erika Dan, mapping properties of water at high latitudes. So, we load B:PLOTTER again from Disk NA-2 and make the following alterations to the program

```
4010 IF ST > 226 THEN END
5200 IF T>2 THEN CLR=2:IF T>3 THEN CLR=3
5300 IF T>4 THEN CLR=4:IF T>5 THEN CLR=5
5400 IF T>7.5 THEN CLR=6:IF T>10 THEN CLR=7
6600 PSET(350+50*(R-26),200+P*180/6000),CLA
```

Line 4010 stops the display after station 226 when the ship reaches the westernmost end of the 53N section (it starts at Ireland on the eastern end of the section). The remainder of the cruise file is north of 53N, so we have called it the "60N" cruise. Lines 5200-5400 now reflect a more limited range in observed temperature as appropriate for high latitudes. Line 6600 replaces the density-oxygen diagram in the lower panel 3 by a density-pressure profile.

So now RUN, enter "60N", RETURN, REC=1, RETURN. We observe that when we first depart from the Irish coast we are in a deep pool of relatively warm water (> 10C), that it is saline, and well stratified in density -- apparently a recent remnant of the water flowing round the subtropical gyre -- although there may be some difference of opinion about this. By the time we get to station 196, the pool of high temperature water has become shallower, and the salinity almost independent of depth. The density is still vertically stratified -- top to bottom -- but the low density water is at shallower depths than farther east. By station 201 the upper 400 decibars has a lower salinity than the deep water. The slope of the S-T diagram has reversed sign through infinity. By station 209 we are descending the western flank of the Mid-Atlantic Ridge southwest of Iceland, and by station 218 the water is close to isothermal vertically, but the density stratification is still stable gravitationally due to the lower surface salinity. The temperature section now shows deep water with cold temperatures < 2C banked up against the continental slope of Labrador, and presumably flowing southward in a thin bottom boundary current that extends upstream to the east side of

Greenland and the straits between Greenland and Iceland where it is fed by overflow from the Norwegian Sea. By station 224 we begin to encounter at the surface the very cold very fresh water flowing southward along the Labrador coast. Stop here or you will get carried northward by the ship.

To get another view of the ventilation of the basins at this 53N latitude, we can reload B:PLOTTER and look at oxygen on the section by the following line alterations

```
5200 IF O>4.5 THEN CLR=2:IF O>5 THEN CLR=3
5300 IF O>5.5 THEN CLR=4:IF O>6 THEN CLR=5
5400 IF O>6.5 THEN CLR=6:IF O>7 THEN CLR=7
```

The cruise is now repeated, starting at REC=1 (off the Irish coast). The oxygen in the warm surface water is, of course, lower than that of the colder surface water farther west. Already, by station 194 it is obvious that at pressures of 500-1200 decibars there is an oxygen minimum in the warm salt water flowing northward off Ireland. Underneath the oxygen is higher -- but especially in the western basin. The maximum oxygens occur at the surface off the Labrador coast and in and close to the bottom boundary current along the foot of the continental rise off Labrador where the strong thin flow from the Norwegian Sea is evident in the temperature section we saw before. There is also a maximum in the western basin at about 1000 decibars, evidently due to the influence of a source of deep water in the winter-time Labrador Sea itself.

4. Some North-South Cruises from Disk NA-1

Put the Disk NA-1 into Drive B and load B:PLOTTER. Look at the program with LIST. On line 5000 you will find that the position-color CLA is set as a linear function of latitude and longitude, so that for either purely north-south or east-west sections it will change color with position. Line 6100 shows Z as a function of LAT. Remembering that Z is the abscissa for the section plot, in the upper left panel of the screen, we see that as set the section will be projected on a vertical meridional plane with LAT=0 on the extreme left. We could start with LAT=-10 at the left of the section so as to accommodate some of the longer transequatorial sections: to do so, simply replace line 6100 by

```
6100 Z = (LAT+10)*3
```

This probably is worthwhile so long as you remember the new scale starts at 10S.

The first cruise to take is an old Crawford cruise that made four sections across the Caribbean Sea. So, load B:PLOTTER, RUN, "carib", RETURN, REC=1, and we are on our way. The cruise starts at Bermuda aimed south toward Puerto Rico, and our program is drawing the property curves for the open ocean in this region. The Crawford moves over to the Virgin Islands and starts southward across the Caribbean, heading for Venezuela.

We now notice that in the deep water of the Caribbean the temperature and salinity appear to be almost constant with depth, so this is the primary evidence of the operation of a sill that separates deep water in the Caribbean basin from deep water of the open Atlantic outside. As the Crawford approaches the southern coast of the Caribbean, it enters the Cariaco Trench, which has a truly shallow sill, and high temperature, salty water fills the deeper portion. The water in this Trench is so stagnant that the oxygens at depth in it are very low.

Another north-south cruise that is fun to replay is the 35W section of the Knorr made by M. S. McCartney in 1983. It starts at Cape Farewell, Greenland, and goes generally southeastward to 35W then southward, and then southwestward to Recife. When we first leave Cape Farewell, we pass through the fresh cold coastal current flowing westward around the tip of the Cape. As the bottom descends, we sample some of the very cold undercurrent sinking down from the Denmark Straits and making its way southward around Greenland, to the Labrador Coast and then evermore southward along the western side of the abyssal Atlantic. The default of the hydrographic section is temperature, colored in 5 degree steps. At 50N we begin to encounter the northern edge of the North Atlantic Current of warm salty water flowing at the surface, to depths of 1000 meters, toward the east. At 35W this current is 20 degrees of latitude in width. When the display has ended, make a replay with the contours of the section set for unit steps in oxygen, which you can arrange as follows:

```
5100 CLR=0
5200 IF O>1 THEN CLR=1:IF O>2 THEN CLR=2
5300 IF O>3 THEN CLR=3:IF O>4 THEN CLR=4
5400 IF O>5 THEN CLR=5:IF O>6 THEN CLR=6
5450 if O>7 THEN CLR=7
```

The oxygen contrasts between deep basins are particularly interesting -- the 35W section wanders from the western basin where it starts, over the Ridge into the eastern basin, and then down in the tropics goes back over into the western basin again. One can see the high oxygen of the North Atlantic Deep Water very much in evidence on the last several stations of the section near Recife.

You will find it interesting to examine the deep temperatures and salinities of this cruise at a higher resolution, using the WINDOW SCREEN instruction to enlarge the display locally.

5. Making Maps

To make a map we need a fair geographical distribution of data -- from many cruises. Disk NA-4 has some utility programs that will make up these special files from all four disks, one after another in Drive B, and write them on a fifth ephemeral disk in Drive A. To get an idea how to use these map drawing utility programs, put Disk NA-4 in Drive B and load B:AUTOPLLOT.

Then put Disk NA-1 into Drive B and RUN. The autoplotter starts with the first cruise on Disk NA-1 and, in the absence of a proper intercept, would plot up all the cruises on the disk, one after another, and of course, would plot points on top of one another in a terrible jumble. So we need an intercept -- line 3700 is an example. Further discussion of intercepts is given below with the program MINIFILE. The intercept rejects all lines of data in the files for which the pressure exceeds 9 decibars. This means that the data that are selected for plotting are essentially surface data: so we will get a surface map. The plots on the hydrographic section, and the T-P, S-P, plots won't make much sense, but the S-T and O-R plots are quite interesting. The color CLA or CLR of the point plotted on the map can be assigned according to temperature, or salinity, or oxygen, for example. The default is temperature in steps of 5 degrees [lines 5100-5400]. If the WINDOW SCREEN option [line 1020] is enabled [as it is by default], then we only see the map enlarged, and the colored dots present us with a crude surface temperature map -- which does not take into account the seasonal differences between cruises.

Let us play around a little with an example using AUTO PLOT on Disk NA-4 in Drive B. We choose the default option of intercept [3700] that rejects all data lines except those with pressure <9 decibars. We choose to make a surface temperature map with colors spaced 5 degrees apart as in lines 5100-5400. Now, with the utility AUTO PLOT loaded, we remove Disk NA-4 from Drive B and insert Disk NA-1 into Drive B and enter RUN. When the files on Disk NA-1 are exhausted, we are prompted to change to Disk NA-2, and type CONT, whereupon the files on that disk are now read, the prompt comes up again and we successively put in Disks NA-3 and NA-4. It takes 10-25 minutes to read through and plot all the disks with AUTO PLOT. It is excessively slow because the program requires that all record numbers be read, and whole lines of surface data be scanned. But it is the simplest program to use, because it does not write any files of its own. The main feature of AUTO PLOT that differentiates it from PLOTTER is that it goes through all the files one by one automatically. To do this it uses the directory of files in lines 20000-23800. At the end of reading the file of a particular cruise, denoted by sequential number N, it returns at line 4700 to line 2110 where it proceeds to open the N+1-th file, and so on until the end [4800]. At the end of a disk it stops and waits for the next disk to be put into Drive B. Everything is done in Drive B. Drive A is not used in AUTO PLOT.

So this is one way to get a map of surface temperature from all the cruise data files. However, if you want to change the temperature color contours, with AUTO PLOT, or look at a map of surface oxygen, you'll have to start from the beginning with a new set of color prescriptions in 5100-5400. And don't forget to keep an eagle eye on the color in line 6200. If it is CLA instead of CLR, you'll get contours of position defined in line 5000 rather than the contour colors you want: CLR.

There is a more efficient and flexible way to get surface maps of various kinds: use MINIFILE in Drive B and a fresh formatted disk in Drive A. With the default intercept in line 3700 you'll get a surface minifile. (Other intercepts can give you minifiles for greater depths, or for surfaces

of constant sigma-theta, for instance). Since you are going to write a minifile on Disk #5 (the ephemeral disk in Drive A) of all the lines that are not rejected, you'll need to give this minifile a name: we suggest calling it "surface" and replacing the default name in line 725, "a:test.dat", by "a:surface.dat". Now the minifile can be opened by that name.

So with MINIFILE loaded in Drive B, and with these modifications entered into the program, take Disk NA-4 out of the Drive B, and put Disk NA-1 into Drive B, and RUN. You will be posted on the screen with how the copying is proceeding. There will be some activity in each of Drives A and B as the proper lines of data are transferred from Disk NA-1 to the minifile on Disk #5 (the fresh newly formatted disk). After awhile you will be prompted to change disks in Drive B, so put in Disk NA-2, then Disk NA-3, then Disk NA-4. The minifile called "surface" will now be on Disk #5 in Drive A. It has all the data for pressures less than 9 decibars. You are now ready to make plots of surface data in any way that you want without having to refer to all the Disks NA-1 to NA-4 over and over again.

Here we digress from actual mapping to say a few words about intercepts as used for building minifiles. When we make a minifile, we reject most of the data lines from the cruise files as we systematically run through them on the four disks using AUTOPLLOT and MINIFILE. This rejection is performed by the intercept in line 3700. The default line is

```
3700 IF PT>9 THEN GOTO 3900
```

which makes a minifile for lines that have $p < 10$, so we can denote this minifile as "a:surface.dat" on Disk #5 in Drive A. You will notice that (for technical reasons discussed in section 7) we have written PT for pressure instead of P (see line 3600). The suffix T attached to a variable means that this is the temporary form used in making the intercept statement in line 3700. Writing the line as

```
3700 IF PT>610 OR PT<590 THEN GOTO 3900
```

will reject all data lines other than the narrow band for which $P = 600 \pm 10$ decibars, so that we might denote this minifile as "a:p600.dat".

Similar minifiles for deeper standard pressures can be made. For example

```
3700 IF PT>1020 OR PT<980 THEN GOTO 3900
```

makes a "a:pl000.dat" minifile, and

```
3700 IF PT>3060 OR PT<2940 THEN GOTO 3900
```

makes a "a:p3000.dat" minifile.

Over much of the depth of the ocean sigma-theta (R) is reasonably monotonic with pressure, so we can make minifiles for single sigma-theta surfaces. For example

```
3700 IF RT>26.53 OR RT<26.47 THEN GOTO 3900
```

makes a "a:R2650.dat" minifile.

If we try to make minifiles from constant values of salinity or oxygen, which are not even approximately monotonic with depth, we may encounter ambiguities in trying to interpret the minifiles or plots from them.

You can use MINIFILE to perform tasks other than preparing minifiles for maps. For example you might want to make a file of all stations that lie along a line from the Labrador Sea to a point off the Gulf of Guinea. Then from this minifile we could draw a composite section, made up of selected full stations that happen to lie close to the proposed line. Suppose that one end of the line is at LAT=60,LON=-55, whereas the other end is at LAT=-10,LON=-10. These two points define the line

$$\text{LAT} = \text{A} * \text{LON} + \text{B}$$

where $\text{A} = -70/45$, $\text{B} = 10 * (\text{A} - 1)$. To select station data within one degree of latitude of this line and write it into a minifile using MINIFILE, we write the line as

```
3700 A=-70/45:B=10*(A-1): Z=LATT-A*LONT-B:
3701 IF Z>1 OR Z<-1 THEN GOTO 3900
```

We can name this minifile "a:diag.dat". When you use PLOTTER now be sure that line 6100 is set to display LAT on the hydrographic section, and you will then draw a nice composite section along the diagonal line.

Now we want to make some maps from the "surface" file. If you have just made the minifile, you have probably forgotten to take Disk NA-4 out of Drive B. Good! We need it there. Now load B:PLOTTER. This will read selected data from the minifiles in Disk #5, and plot them on a map in various ways.

Suppose that we now want a surface salinity map. We can set salinity contour colors in lines 5100-5400. Then RUN. Then we are asked what minifile we want, and we type "surface".

The map begins to form. You will find that making minifiles with MINIFILE and then using PLOTTER to plot them up in various ways is quite convenient for drawing all kinds of maps. Therefore you will probably gradually accumulate on Disk #5 a set of minifiles for various sigma-theta surfaces and pressures. We found that we could use the nomenclature "P1000" to denote data at pressure 1000 decibars [in the intercept we would reject lines for which $\text{P} > 1020$ or $\text{P} < 980$, for example]; or, for example, "R2710" to denote sigma-theta 27.10 [in which the intercept would reject lines lying outside a narrow band of sigma-theta's centered at 27.10].

You might like to make a map that shows the seasons when the various sections were made. You can get a MINIFILE to make such a map easily by entering the following lines


```

1000 'WINDOW SCREEN (0,-20)-(640,400)
1030 WINDOW SCREEN (390,180)-(701,0)
5100 CLR=1:IF MN>3 then CLR=2
5200 IF MN>6 THEN CLR=3
5300 IF MN>9 THEN CLR=7

```

Now, input "surface". The map shows the four sets of months 1-3, 4-6, 7-9, 10-12 in different colors. It is rather sobering to realize how thinly sampled the seasons are in this data set. Autumn is notably sparse.

Suppose that we want to draw a map of some property at pressure 600 decibars. Then we will enter "p600" upon the prompt. This gives us entry to a file of all lines for which the pressure lies between 580 and 620 decibars. Let us proceed to draw a map with the default values for assigning color contours. What really strikes the eye is the remarkable series of distinctly separate functional relations on the S-T diagram despite the more or less continuous geographical coverage of the data. How can we explain this? Or at least can we locate on the map where these peculiar water masses exist?

By trial and error we can succeed in gerrymandering the S-T plane so that there are different colors for each of the arms of the distinct S-T relations. One such coloring scheme is

```

5100 IF R<27 THEN CLR=4: IF R<26.75 THEN CLR=5
5200 IF R<26.5 THEN CLR = 6
5300 IF S>35.6 and CLR=2 THEN CLR=5:IF R>26.7 THEN CLR=7
6200 PSET(X,Y)CLR:CLA=CLR

```

By rerunning the mapping program B:PLOTTER with these substitute lines, you'll be able to identify what portion of the ocean at 600 decibars is responsible for each arm of the S-T relations. It is a feature worth thinking about -- especially since there seem to be regions of "non-water" on the S-T plane.

FASTSCAN is another utility program that works with your minifiles. It reads selectively from the minifiles. By this we mean that it does not store complete lines from minifiles, just a selection: for example it reads only the map coordinates X(I),Y(I) and temperature T(I) from each line in the "surface" minifile. Then it stores these in an internal memory array, and then sorts them according to latitude.

After the sorting, it plots them on the map, assigning a color that depends upon a single temperature. This temperature is shown at the bottom of the screen. So what we see on the screen is, in effect, a single temperature contour. But we can change the temperature corresponding to this contour move by manipulating the cursor keys. The numerical designation of cursor keys varies with machines, so you may have to reassign the numbers in lines 350, 30600, 30700.

FASTSCAN corresponds most closely to the old program proposed by Pivar, Fredkin and Stommel (1963). It is very handy searching for extremes, or small property differences.

6. Anomalies True and False

Most listings of large sets of data contain errors large and small. The large ones can generally be spotted by eye, and if left undetected could wreak havoc with averages etc. They can also stop a program by calling for an illegal quantity like a negative color. Let us look for some big ones first. An oceanographic station plotted in the Sahara desert must be incorrect; there is also something wrong with stations that are supposed to be in the Atlantic but show up in the Pacific. For example, when looking at "surface.dat" data plotted by B:PLOTTER on Disk NA-4, there is what appears to be a station misplotted far to the left of the margin of the map. One can scan the file for this kind of error to find all points in the file that lie outside the margin by setting in the following lines

```
3610 IF LAT>70 or LAT<-10 THEN LPRINT REC 'plus
      any other variable you want printed
3620 IF LON>10 OR LON<-100 THEN LPRINT REC 'etc.
```

and running the "surface.dat" file from Disk #5 in Drive B. It prints out the record numbers of the guilty lines of data:

```
1276
2522
2523
```

Thus there are three such data points out of a total of 3013 records in the file. When there are only a few such errors, it is easy to scan specifically for them in the operating program each time it is used, instead of erasing them from the file.

The most pervasive errors that have spread from the NODC tapes into our disk files are station numbers with the last digit missing. We have tried to correct our files where this has occurred: those marked in Table I with a single asterisk. In the case of N = 21, the R.V. Baffin cruise, there are no station numbers on the tape, and we put none on the disk: this file is marked with a double asterisk.

Much more interesting are seemingly wild anomalous data points that might be errors, or possibly might be real discoveries. As an example that we uncovered while playing with Disk NA-4 and "surface.dat" file, we offer the following for consideration. Suppose that we look at surface salinity maps. In particular we are interested in delineating where the lowest surface salinities are to be found. Then we can set the following lines in B:PLOTTER:

```
1000 'WINDOW SCREEN(0,-20)-(640,400)
1030 WINDOW SCREEN (390,180)-(701,0)
5100 CLR=1
5200 IF S>32 THEN CLR=2: IF S<30 THEN CLR=4
5300 IF S<10 THEN CLR=7:BEEP:LPRINT USING
      "rec=####,S=##.###";rec,S
6100 Z= 3*LAT
```

Line 1030 enlarges the map so that it fills the screen. Line 5300 intercepts values of salinity $S < 10$ and tells the printer to print these lines out. Lines 5100-5200 define the salinity-color relation.

When we run this program we find, as expected, that there are places around the coasts with low salinity. There are even a few records with $S=0$,

```
rec=1477 S=0.000
rec=1570 S=0.000
rec=1819 S=0.000
rec=2005 S=0.000
```

which is an error or which means that no salts were determined: one is in the Sahara, one in the Labrador Sea, two are in the middle of the dense Gulf Stream surveys. But what really strikes the eye is the spot of low salinity observed on M. McCartney's 52W CTD section well offshore of Brazil. There are some surrounding cruises made by the Crawford in earlier years and they do not show such low salinity spots so far offshore. Could this be a surface pool of Amazon River water? Or has the file been contaminated? Or is this one of those cases where use of a CTD gives erroneous near-surface measures? A check against the detailed CTD data soundings for these stations pretty much dispells any doubt about the accuracy of the data. So this, most likely, is evidence of an off-shore pool of river water. On the other hand, the companion CTD section at 64W has a rather intense fresh water segment north of the Gulf Stream, more so than adjoining older sections, so one is entitled to be a little skeptical -- is there something odd about near-surface CTD data? However, this is not the place to address such weighty scientific questions -- we simply offer this as an example of how discovery and error are sometimes intertwined, and how even a cursory study of data can lead to puzzlement.

The celestial mechanician Dirk Brouwer once sent questionnaires to astronomers enquiring what kinds of numerical errors they made. He received a reply from a stiff Middle European which stated simply "I do not make mistakes". Well, the data files on these disks do have errors of measurement and transcription. Anyone who studies data must learn to deal with errors. We know of a few that you may want to know about, or rediscover.

Recently Saunders (1986) has made a study of the T-S relation of the abyssal waters of the eastern North Atlantic. He finds a remarkably sharp functional relationship between potential temperature and salinity in modern cruises. He pointed out to us privately that one of the beta spiral cruises (AT109), which we call here "beta", has some suspicious abyssal salinities. We checked back into the original logs and remembered that on the beta leg of AT109 we did not have our trusted oceanographer G. Knapp doing the salinometer calibrations. So perhaps that accounts for the less-than-perfect salinities on "beta". You should try comparing the abyssal T-S diagram of "beta" with the eastern basin portions of "24-36n" which appear to have been done better. We also include a file called "beta2" for an earlier beta spiral cruise (OC078) on which the abyssal salinities are good. You can compare "beta" and "beta2", to explore and verify these discrepancies. Of course,

always in the background there is the nagging question "are those 'beta' salinities really wrong? or do they indicate a temporary cloud of water influenced by Antarctic Intermediate Water?"

You can experience the opposite side of this coin, or hoist yourself on the other horn of the dilemma, by running "beta2" (OC078) (Disk NA-4) on PLOTTER. At one station there is a very wild-looking vertical profile of both temperature and salinity, with anomalously high salinity centered near 1000 decibars. If this had been a bottle station, and salt determination delayed until coming home, it might have been rejected as a bad observation. But this is not an error. It was confirmed, on the spot, as it happened. It is a station in which L. Armi (& Stommel, 1983) first discovered his salt lens floating away from the Strait of Gibraltar.

7. Utility Program Logic and Description

The set of utility programs included on the various Atlantic disks has been built up from common program elements which the user can modify to ask other questions than we have discussed above. The data files have a common format, based on the Microsoft Basic random access file structure. All of the data are stored as integers which are accessed through a buffer specified by a field statement. Each data cycle must be either put into the buffer to write a file, or gotten from the buffer to read.

MAKER.BAS

The first program in the sequence is called MAKER.BAS. Generally you will not use MAKER.BAS unless you want to add to the number of cruise data files on floppies, by transferring data from NODC-type files to our format. You might use it also for making a collection of cruise files for the Pacific Ocean. But if this is the first time you are using this disk atlas, you ought to skip over this, and go on to the next utility program. This program takes existing hydrographic or CTD data, presumably in ASCII format in some file, denoted by CIN\$ [line 700]. Data will be read sequentially from CIN\$. The output file is specified by COUT\$ [line 900]. This is the random access file whose records are 18 bytes long, corresponding to 9 integers as specified by

```
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,  
2 AS S$,2 AS O$,2 AS R$
```

The variables are station number, latitude, longitude, date, pressure, temperature, salinity, dissolved oxygen and sigma-theta, respectively. To be stored as integers, the following conversions must be made

```
3800 LAT = INT (100*LAT):LON=INT(100*LON):DT=100*YR+MN  
3900 T = INT(1000*T): S=INT(1000*(S-15)):O=INT(100*O):R=INT(1000*R)
```

The reading of the input file begins in line 3200, by checking for an end of file, reading a data cycle [3300], decoding it [3400-3700, or some equivalent], scaling it [3800-3900], setting up the random file buffer [4000-4200] and finally writing to buffer to the output file [4300]. Then the cycle begins again until an end of file is reached.

READER.BAS

The next program is called READER.BAS. This program reads data from a random access file and displays the data on the screen. All of the display and plotting programs that follow use the acquisition part of READER. This program begins by setting a default disk:directory, DEF\$, in which the data files, *.dat are to be found. The default is "b:", but this must be changed if the atlas is installed on a hard disk [see Appendix 1 on hard disk installation]. Next a screen command must be given to configure the graphics screen, although not strictly required for READER which just lists data. A discussion of the various options for graphics is given in Appendix 1. Next the program displays the *.dat files in the default directory

```
600 FILES DEF$+"*.dat"
```

which results in the following type of display (Disk NA-1):

```
B:
BDAE   .DAT    64W   .DAT    52W   .DAT    35W   .DAT
CARIB  .DAT    BETA  .DAT    BDAW   .DAT    BDAS   .DAT
57W    .DAT    DRAM  .DAT
6144 Bytes free
```

after which you can select one of the files, say 35W. The program then forms the complete file name, B\$. Next the program requests that you specify a starting record number, REC. On other disks there are some files (e.g., 24-36n, 8s-8n) which contain more than one section so that one can begin the display at REC>1 for those cases (see discussion in Appendix 1). Then the file is opened [line 3000] and the field set up [line 3100].

```
3000 OPEN "R",#2,b$,18
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,
2 AS S$,2 AS O$,2 AS R$
```

The data acquisition loop starts at line

```
3200 IF EOF(2) THEN GOTO 4300 'check for end of file, if so quit
3300          GET#2,REC      'get record=REC.
```

The integer data is decoded from the byte strings in 3400-3500 and converted to physical units in 3600.

```
3400          DT=CVI(DT$):P=CVI(P$):T=CVI(T$):S=CVI(S$):O=CVI(O$):R=CVI(R$)
3500          ST=CVI(STN$):LAT=.01*CVI(LAT$):LON=.01*CVI(LON$)
3600          YR=INT(DT/100):MN = DT-100*YR: T=T/1000:S=S/1000+15:
          O=O/100:R=R/1000
```

where the variables are station number (ST), latitude (LAT), longitude (LON), year (YR), month (MN), pressure (P), temperature (T), salinity (S), dissolved oxygen (O) and sigma-theta (R). The variables are then printed in 3700.

The record number REC is incremented and the program returns to 3200 to acquire another data cycle. All of the remaining programs build on the file entry and data acquisition discussed in READER.BAS.

PLOTTER.BAS

The next program in the sequence is PLOTTER.BAS which reads one of the files and displays the observations in various forms. This program depends upon the details of the graphics capabilities of your system.

The version of PLOTTER on Disk NA-2 is written in SCREEN 1 for a three-color machine. On Disk NA-3 there are three versions:

PLOTTER1 -- same as PLOTTER using SCREEN 1, for IBM with CGA using BASICA (DOS \leq 3.2) with 3 colors

PLOTTER3 -- for NEC APC III using SCREEN 3 and Microsoft GW-Basic with 8 colors

PLOTTER9 -- for IBM using SCREEN 9 with EGA using QuickBasic or BASICA (DOS 3.3) and 15 colors available

Depending upon your machine you will make a choice with best resolution and largest number of colors. A detailed discussion is given in Appendix 1.

The program begins as READER.BAS does. Once the file and the starting record (REC) have been selected, the program sets up the plotting domain with three types of plots -- a plan view map in the upper right hand corner, a section plot of longitude or latitude vs pressure and four diagnostic diagrams, T - p, T - S, O - R and S - p.

To set up the screen, we begin by defining the screen coordinates with

```
1000 WINDOW SCREEN (0,0)-(640,400)           'default window
```

In the upper right, we draw the border for a map of the North Atlantic

```
1300 LINE(411,21)-(629,179),1,B
1400 LINE(410,20)-(630,180),1,B
```

In the upper left, a grid for the section plot (latitude or longitude vs pressure)

```
1500 FOR y = 0 TO 100 STEP 10 :FOR p = 0 TO 6000 STEP 1000
1550 YY=3*Y: ZZ=180*P/6000
1600 LINE(0,ZZ)-(YY,180),1,B
1700 NEXT :NEXT
```

The scale lines are drawn at 10 degrees of latitude or longitude, 1000 dbars in pressure. For the diagnostic diagrams, the pressure scale is 2000 dbars.

```
1800 FOR J = 0 TO 3:FOR P = 0 TO 6000 STEP 2000
1850 ZZ=200+180*P/6000
1900 LINE(50+150*J,ZZ)-(150+150*J,380),1,B
2000 NEXT :NEXT
```


The outline of the continental boundaries is drawn at line 2100 where the program branches to line 10000, reads data from the file MAP.FIL. This file consists of latitude and longitude for points on the boundaries and islands, so that the only tricky point is whether the boundary is continuous -- jumps are detected in line 10700. The plotting of the coastline is often time consuming and can be aborted by typing the spacebar after which the file is closed and the program continues at the BEEP command in line 2100.

```

10000 'plot MAP of N. Atlantic
10050 MAPFIL$=DEF$+"map.fil"
10100 OPEN "r",#1,MAPFIL$,4
10200 FIELD#1, 2 AS X$,2 AS Y$
10300 IF EOF(1) THEN GOTO 11400          'doneend of file
10400 GET#1:X=CVI (X$):Y=CVI (Y$)
10500 Y=CVI(X$):X=CVI(Y$)
10600 X = X/5+180 :Y=Y/5
10700 IF (X-X0)^2+(Y-Y0)^2>20 THEN GOTO 11000 'check for jumps
10800 LINE(410+X,160-Y)-(410+X0,160-Y0),1
11000 PSET(410+X,160-Y),1
11100 X0=X:Y0=Y
11200 IF INKEY$=" " THEN GOTO 11500      'spacebar to quit
11300 GOTO 10300
11400 'GOSUB 12000                      'paint in land masses-optional
11500 CLOSE#1
11600 RETURN

```

If you allow the map to be completed, the routine goes to line 11400 which contains an optional routine to fill in the land masses using the paint command [see listings in Appendix 2, lines 12000-13700], after which the file is closed and control returns to line 2100. The program continues by allowing you to choose REC to start, opens the file and begins to acquire and decode data cycles, completed by line 3700.

All of the color selection and plotting occurs in the routines starting at lines 5000 and 6000.

```

3700          GOSUB 5000      'get colors
3800          GOSUB 6000      ' plot

```

As we have written the color selection routine, two colors are chosen, CLA to correlate points on the diagnostic plots with their geographical position on the chart, and CLR to show temperature on the section plot. This latter is the "poorman's" (non-interpolated original data) contouring since the color boundaries are temperature contours. Obviously other choices for the color variables can be made to show other properties, as discussed in previous sections. These changes can be made in the color routine starting at line 5000.

```

5000 CLA = 1+INT((LAT+10)/12) MOD 6           'color for map
5100 CLR = 1                                   'color for section
5200 IF T>5 THEN CLR = 2:IF T>10 THEN CLR=3    '      "
5300 IF T>15 THEN CLR = 4 :IF T>20 THEN CLR = 5 '      "
5400 IF T>25 THEN CLR = 6 :IF T>30 THEN CLR = 7 '      "
5500 RETURN

```

The versions of PLOTTER on Disks NA-1 and NA-2 (shown here) differ only in lines 5000 where CLA is defined and in 6100 where the abscissa for the section plot Z is defined. On Disk NA-2, the following changes are made

```

5000 CLA = 1+INT((LON+100/10) MOD 6
6100 Z= 3*(LON+100)

```

The plotting begins at line 6000 with specifying the coordinates for the various plots -- geographical (x,y), section (z,p) and the diagnostic diagrams.

```

6000 Y=160-2*LAT: X=590+2*LON
6100 Z= 3*(LAT+10)
6200 PSET(X,Y),CLA                               'map
6300 LINE(Z,180*P/6000)-(Z+1,180*P/6000+1),CLR,BF 'section
6400 PSET(50+4*T,200+P*180/6000),CLA             'T - p
6500 PSET(200+ 50*(S-35),380-5*T),CLA             'T - S
6600 PSET(350+ 20*(R-23),380-10*O),CLA            'O - R
6700 PSET(500+ 50*(S-35),200+P*180/6000),CLA      'S - p
6800 RETURN

```

The BF command in line 6300 denotes a filled box, whereas the other commands draw color dots or points (PSET).

As we discussed in the previous sections, different areas of the screen can be magnified by changing the window screen command in line 1000. There is no need to change the plotting routine, the plots not shown on the screen are drawn by the computer but not displayed -- they are off the edge of the "paper".

After the completion of the color and plotting routines, the REC is incremented and the program continues to cycle from line 4400 back to 3200. The program halts after the end of file is reached.

It is often useful to plot a derived quantity such as potential temperature, sigma-theta or percent saturation of dissolved oxygen. Routines have been included for these quantities. It is easy to incorporate these into any of the programs by using the BASIC merge command. The line numbers for those files are different from any of the line numbers in the other programs so that any or all of these routines can be added to any of the programs.

To plot a potential temperature section for example, we could invoke the BASIC interpreter, load "PLOTTER" and then merge "POTEMP.BAS" which would

load lines 40000-42200 at the end of plotter. You would then need to include a statement early on, say

```
2010 GOSUB 40000
```

which sets up the array $a(4,4,4)$ and coefficients needed for the calculations. The actual calculation is done by inserting

```
3650 GOSUB 41000
```

after the variables T and P have been obtained. The variable TPOT is then the potential temperature. Setting $T=TPOT$ at 3675 and continuing with the color selection and plotting unchanged would give a section and diagnostic plots with potential temperature substituted for temperature. Other variables could be plotted similarly. The additional routines are given with the program listings, and are based on the formulae given by Bryden (1973) and Fofonoff & Millard (1983).

The remaining programs are on Disk NA-4 and consist of special purpose programs to develop and display subfiles or minifiles containing a subset of the data on the original data files, such as the surface data ($0 < P < 9$) or data on a particular density surface. The first of these is AUTOPLOT which plots data selected from each of the data files. The second is MINIFILE which generates a file of selected data cycles. Some special files that were made using MINIFILE have been included on Disk NA-4: SURFACE.DAT is data from all stations with $P < 9$; P3000.DAT is data from all stations with $2900 < P < 3100$. Other special files can be made quite easily with MINIFILE.BAS.

AUTO PLOT.BAS

This program plots data from each of the files on Disks NA-1 through NA-4 sequentially. In order to handle the multiple disks, several changes have been made to the basic program PLOTTER9. The version presented is written for IBM with EGA. To modify for IBM with CGA you must choose the SCREEN 1 option and rewrite all LOCATE statements to LOCATE 1,28. An array of file names is set up so that the program "knows" what data files are on the set of disks. These arrays are dimensioned in line 600 whereupon the program branches to line 20000 to define the array variables C\$(I) and D\$(I).

```
600 dim C$(40),D$(40)           'array of file names and mnemonics
700 GOSUB 20000                  'set up arrays C$,D$
```

The C\$ array gives the NODC cruise name for each of the 38 files, and D\$ is the corresponding mnemonic used as the file names for the data files. The variable N is used as the index for the files, initially chosen as 0, and incremented in line 2110.

The program continues choosing a window screen, the default is line 1020 corresponding to a full screen map. Just as in PLOTTER, the program branches to line 10000 to draw the continental boundaries. The program loop starts with line 2110 where N is incremented, sets the file name B4 to be opened, sets REC=1, opens the file and acquires a data cycle. In line 3700 an interrupt is defined which selects those data cycles which are plotted. The default is choosing the near-surface values with P < 9. Other choices can easily be substituted in line 3700.

```
3700 IF P > 9 THEN GOTO 3900
```

If the data is accepted, the colors are chosen and plotted (routines at 5000 and 6000); otherwise it jumps to 3900. The REC is incremented and continues as in PLOTTER until an end of file is reached. In this case, the file is closed, and N is checked to see if there are still more files in the list (N<36), if so then back to 2110.

When the files on the present disk are exhausted, say N=11(D\$(11)="60n") with Disk NA-1 in Drive B, the OPEN command in line 3000 will give an error, "DISK WRITE PROTECT" because the program tried to open this file on a write-protected disk. Ordinarily the program would display an error message and halt. To prevent this, and to provide a prompt to put in the next disk, the program is modified to intercept the errors, the instruction for this is found in line 150,

```
150 ON ERROR GOTO 25000 'intercepts errors for disk protected
```

where a trap for the error is introduced. Any time that the program encounters an error, it goes to line 25000, where the following steps are found:

```
25000 LOCATE 1,1
25100 IF ERR<>70 THEN PRINT "error # = ";ERR:STOP
25200 PRINT "insert next disk then any key to continue"
25300 WHILE INKEY$="": WEND      'pause until key is struck
25400 LOCATE 1,1
25500 PRINT "                  "
25600 RESUME
```

The error code is variable ERR, which for a disk write protected error has ERR=70. Any other value for ERR(<>70) will halt the program. If ERR=70, the program prints the message in line 25200, and then waits for you to insert the next disk. Striking any key will cause the program to continue, erasing the message on the screen, and resume execution at the point where it had branched to 25000.

MINIFILE.BAS

This program is set up to read all of the original data files successively from the 4 disks. The program is based upon AUTOPLLOT.BAS. This program differs from AUTOPLLOT by producing a new file, in ATLAS format which can be read or plotted. Data can be selected from any of the data files on Disks NA-1 through NA-4. A unique output file name must be chosen, for with random access files, data can always be added to the existing file without warning you, unless the disk is write-protected. As an example, we choose "a:test.dat" on a scratch disk. This file is opened and the format of the internal buffer established

```
725 COUT$="test.dat"
750 OPEN "R",#1,COUT$,18
775 FIELD#1,2 AS STNM$,2 AS LATM$,2 AS LONM$,2 AS DTM$,2 AS PM$,
    2 AS TM$,2 AS SM$,2 AS OM$,2 AS RM$
```

where the field variables must have different names (e.g. LATM\$) from those for the input files (LAT\$). The loop for the 35 file names begins at 800, and ends at line 4700 where we check to see if the list has been exhausted (N>35). Just as with the other programs, lines 2200-3500 set the starting REC, open the file and acquire a data cycle. Because the original data variable [for example, R] is usually not an integer, but encoded as an integer [1000*R], a temporary value [for example, RT] is formed [line 3600] for use of the intercept [line 3700] in MINIFILE. This is different from line 3600 in the other programs. These temporary variables are labelled with a suffix T, then RT is a temporary decoded value of R to be used for the intercept to read and work upon.

Use of temporary values may seem cumbersome, but we find that in BASIC our MINIFILE malfunctions if all variables are decoded from integers in the input buffer and re-encoded to integers for the output buffer. The use of temporary variables avoids the decoding and re-encoding. At line 3700 the intercepts for accepting or rejecting a data cycle are defined, in this example, accepting records whose pressure is less than 9 dbars.

```
3700 IF PT>9 THEN GOTO 3900          'select records to keep
```

If a data cycle is accepted, the data is placed in the output buffer (LSET..., must match FIELD#1) and put into the output file. If the data cycle is rejected, the program jumps around these steps and continues at line 3900 to increment REC, check the keyboard, and get another data cycle.

```
3600 PT=P: DTT=DT: LATT=LAT/100: LONT=LON/100: TT=T/1000: ST=S/1000+15:
    RT=R/1000: OT=O/100              'temporary values for interrupts
3700 IF PT>9 THEN GOTO 3900          'select records to keep
3800 LSET DTM$=MKI$(DT):LSET STNM$=MKI$(ST):LSET RM$=MKI$(R)
3830 LSET PM$=MKI$(P):LSET TM$ = MKI$(T):LSET SM$=MKI$(S):LSET OM$=MKI$(O)
3840 LSET LATM$=MKI$(LAT):LSET LONM$=MKI$(LON)
3850 PUT#1
```

```
3860 LOCATE 15,1:PRINT USING " ####      ###.##  ###.##";  
      ST,PT,LATT,LONT  
3870 LOCATE 20,1                      'wait here from errors  
3900 REC = REC+1 'update REC  
and finally check if there are more input files.  
4700 IF N >35 THEN LOCATE 18,1 : CLOSE#1 : STOP
```

FASTSCAN.BAS

The final program in the series is called FASTSCAN.BAS which allows one to contour data interactively using the cursor keys to shift the color boundary while sweeping through the data. This particular version of FASTSCAN works with a map of surface temperature from SURFACE.DAT (Disk NA-4), but the program can be modified easily to contour surface salinity, deep (4000 db) temperature or to make enlarged section plots of oxygen, potential temperature or whatever. The structure of the program is similar to PLOTTER as discussed above except that the data are stored in a large array so that they can be scanned rapidly after altering the contour level with the cursor keys.

The first change from PLOTTER occurs at line 350 where the cursor keys 11 and 14 are activated. These numbers are machine dependent, depending on how many function keys are present on the keyboard (IBM AT=10, NEC=12 so for the NEC need to activate keys 13,16). If you change these, you will have to change the corresponding numbers in lines 30600 and 30700.

```
350 KEY(11) ON:KEY(12) ON:KEY(13) ON:KEY(14) ON  'machine dependent!!
```

Next we need to set up the integer arrays for latitude, longitude and temperature or whatever variable is being contoured. To save storage space, the integer equivalent of the variable is saved (see line 3510). NUM is the total number of data cycles expected.

```
370 NUM= 3200
```

```
375 DIM X%(NUM),Y%(NUM),T%(NUM),INDEX%(10,1000),n%(10) 'save as integers
```

where X%,Y% and T% are the LON,LAT and TEMP, INDEX% and N% are used to carry out a coarse sorting of the data by latitude. INUM is the index used in setting up the arrays X%,Y% and T%.

```
380 INUM=0
```

For contouring, we choose two colors depending upon whether $T > T_9$ or $T \leq T_9$, T_9 is specified here. DELT is the increment by which T_9 is changed by striking the cursor keys. T_9INT is the integer equivalent of T_9 , so that the contour routine doesn't have to convert into real numbers each time.

```
390 T9=15 :T9INT=1000*T9 :DELT=.25 :GOSUB 15000  'scales for contours
```

The routine at 15000 annotates the screen in line 25 with the colors and contour value. The program proceeds to acquire data, keeping the integer equivalent of T in 3510

```
3510 TINT=T
```

specifying the color at 3700 and plotting at 3800.


```

3700          GOSUB 5000      'get colors
3800          GOSUB 6000      ' plot also specify arrays

```

The color setting routine is straightforward

```

5000 IF TINT<T9INT THEN CLR=2 ELSE CLR=5      'integer temps=TINT
5100 RETURN

```

while the plotting routine is more complex since the data storage and indexing occurs here as well. The array INDEX%(I,J) is a list, J=1 to N%(I), of the indices of the arrays X%, Y% and T% whose latitude falls into the ith bin, where I is defined as the integer(latitude/10)+2 [line 6200]. This coarse sorting of the data allows us to re-plot the observations in latitude bands, rather than in the more random order of the original data files.

```

6000 Y=160-2*LAT: X=590+2*LON
6100 INUM=INUM+1: X%(INUM)=X: Y%(INUM)=Y: T%(INUM)=TINT      'set arrays
6200 II=INT(LAT/10)+2      'set up index for coarse sorting
6300 N%(II)=N%(II)+1
6400 INDEX%(II,N%(II))=INUM
6500 PSET(X,Y),CLA      'map only
6800 RETURN

```

In order to avoid overflowing the data arrays, we check INUM before continuing.

```

3810      IF INUM=NUM THEN GOTO 4600      ' make sure don't overflow arrays

```

Once the data have been acquired, the interactive plotting begins at 30000. This routine begins by refreshing the contour display (15000) and then begins to plot the data in the latitude bins, II=1 to 10, JJ=1 to N%(II). At each stage in the loop the cursor keys KEY(11) and KEY(14) are checked. If they have been touched, the program branches to routines at line 32000 or 33000, otherwise the program continues to plot. Typing the spacebar temporarily halts the program.

```

30000 GOSUB 15000      'update scale display
30100 II=0
30200 LOCATE 25,60:PRINT "done";
30300 II=II+1 : JJ=0 : IF JJ>10 THEN GOTO 30100      'start over
30400 JJ=JJ+1 : IF JJ>N%(II) THEN GOTO 30300
30500 K=INDEX%(II,JJ)
30600 ON KEY(11) GOSUB 32000      'up
30700 ON KEY(14) GOSUB 33000      'down
30800 TINT=T%(K):GOSUB 5000      'get color
30900 PSET (X%(K),Y%(K)),CLR
31000 Q$=INKEY$
31100 IF Q$="" THEN WHILE INKEY$="" :WEND
31200 GOTO 30400

```

The cursor control routines if activated increase or decrease the contour T9 by DELT. Remember these are initially set at line 390. To avoid using real numbers, need T9INT% as well for the color routine [5000].

```
32000 'key up
32100 T9=T9+DELT : T9INT%=1000*T9
32200 LOCATE 25,60:PRINT "    ";
32300 GOSUB 15000
32400 RETURN
33000 'key down
33100 T9=T9-DELT : T9INT%=1000*T9
33200 LOCATE 25,60:PRINT "    ";
33300 GOSUB 15000
33400 RETURN
```

The program can easily be modified to plot other quantities such as salinity, dissolved oxygen or whatever, and to plot section plots or diagnostic diagrams by modifying the plotting instructions and the window screen.

Appendix 1. Graphics, BASIC Interpreters and Compilers

These programs were all written for a NEC APC III with color graphics using the GW-BASIC interpreter, and using an IBM PC/AT with Enhanced Color Adapter/Display using the modifications discussed here. The NEC has a 640 by 400 screen with 8 colors available simultaneously, which can be readily accessed in the Microsoft GW-BASIC version for the NEC with the SCREEN 3: COLOR 0,2 commands. The two most common alternatives are the IBM PC (XT or AT) with Color Graphics Adapter/Display (CGA) and IBM PC with Enhanced Graphics Adapter/Display (EGA) or the various clones. The CGA system has a resolution of 320 by 200 with 3 colors, accessed in BASICA by the command SCREEN 1:COLOR 0,2. The EGA has a resolution of 640 by 350 with 16 simultaneous colors. This can be accessed in BASICA (Version 3.3 only) or in the Microsoft QuickBasic (Versions \geq 2.0) by the commands SCREEN 9:PALETTE. With BASICA version earlier than 3.3, only the CGA equivalent is available. These three commands are all given in the programs at lines 400-402. The wider or smaller range of available colors can be changed in lines beginning at 5000. If you are using the CGA mode, the LOCATE commands which write to the screen in various places will have to be changed because of the reduced resolution of the screen (25 lines by 80 characters to 12 lines by 40 characters).

The BASIC programs have been stored in ASCII on the disks so that they can be edited and/or read by a variety of other machines, interpreters and compilers. The speed and ease of use of the newer BASIC compilers is very nice but we feel that the results using the interpreted BASIC are well worth it. We do not have sufficient experience with other compiled languages on PCs to be able to offer versions of the ATLANTIC disks for the other possibilities.

It is of course easier and faster to transfer all of the files to a hard disk if one is available. It is desirable to have the files on a single subdirectory, which can then be specified as DEFLT\$ in line 200 of all of the programs. To make a subdirectory, e.g. c:\atlantic, use the following sequence of commands in MS-DOS,

```
c:
md \atlantic
cd \atlantic
copy a:*.*
```

repeating this last command for each of the Atlantic disks. It will be important to modify each of the programs in line 200 for the default directory, DEFLT\$. Otherwise, you may end up with a proliferation of files of zero length which are opened as random access files by MINIFILE.

Appendix 2. Program Listings

MAKER.BAS

```

100 ' maker - makes random access files in atlas format
300 CLS: KEY OFF
400 ' SCREEN 3: COLOR 0,2      'NEC APC III using Microsoft GW-Basic
401 ' Screen 9:palette        'IBM with EGA using QuickBasic or BASICA(DOS 3.3)
402 SCREEN 1:COLOR 0,2        'IBM with CGA using BASICA(DOS <= 3.2)
600 PRINT "maker: makes files in format for ATLANTIC programs"
700 INPUT "enter complete input file name ";CIN$
800 OPEN "I",#1,CIN$          'assume input file is a sequential ascii file
900 INPUT "enter complete output file name ";COUT$
3000 OPEN "R",#2,COUT$,18     'output will be random access file
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS
   OS$,2 AS RS
3200 IF EOF(1) THEN GOTO 4500      'end of input file
3300 INPUT#1,AS
3400 P = VAL(MID$(AS,49,5)): T = VAL(MID$(AS,54,6)):S=VAL(MID$(AS,60,6))
3500 YR = VAL(MID$(AS,19,2)): MN=VAL(MID$(AS,21,2)): DY=VAL(MID$(AS,23,2))
3600 O = VAL(MID$(AS,66,6)): R = VAL(MID$(AS,72,6)): STN =VAL(MID$(AS,8,4))
3700 LAT = VAL(MID$(AS,26,7)):LON=VAL(MID$(AS,33,8))
3800 LAT = INT (100*LAT):LON=INT( 100*LON):DT=100*YR+MN
3900 T = INT(1000*T ): S=INT(1000*(S-15)):O=INT(100*O):R=INT(1000*R)
4000 LSET DT$=MKI$(DT):LSET STN$=MKI$(STN):LSET R$ = MKI$(R)
4100 LSET P$= MKI$(P) :LSET T$ =MKI$(T) :LSET S$ =MKI$(S)
4200 LSET O$= MKI$(O):LSET LAT$=MKI$(LAT):LSET LON$=MKI$(LON)
4300 PUT#2          'put buffer into file #2
4400 GOTO 3200
4500 CLOSE#1
4600 CLOSE#2
4700 PRINT "finished"

```

READER.BAS

```

100 ' reader - reads data files and lists results
200   DEFLT$="b:"
300 CLS: KEY OFF
400 SCREEN 2
500 PRINT "reader      files available:
600 FILES DEFLT$+"*.dat"
700 INPUT "enter file name[without .dat] ";C$:CLS
800 LOCATE 1,60: PRINT C$
900 B$=DEFLT$+C$+".dat"           'complete file name
2200 LOCATE 1,68:INPUT "rec= ";REC
2300 LOCATE 1,60:PRINT "          "
2400 LOCATE 1,60:PRINT C$;REC
3000 OPEN "R",#2,B$,18           'using complete file name=b$
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS
   O$,2 AS R$
3200 IF EOF(2) THEN GOTO 4500     'check for end of file, if so quit
3300   GET#2,REC                 'get data cycle
3400   DT=CVI(DT$):P=CVI(P$):T=CVI(T$):S=CVI(S$):O=CVI(O$):R=CVI(R$)
3500   ST=CVI(STN$) :LAT=.01*CVI(LAT$):LON=.01*CVI(LON$)
3600   YR=INT(DT /100): MN = DT-100*YR: T=T/1000:S=S/1000+15:O=O/100:R=R/1000
3700 PRINT USING"#### ###.## ##.## 19## ##  #### ##.### ##.### ##.## ##.### re
c=####";ST,LAT,LON,YR,MN,P,T,S,O,R,REC
3900   REC = REC+1
4200   ZZ$=INKEY$
4300   IF ZZ$=" " THEN WHILE INKEY$=" ":WEND           'check keyboard
                                                    ' use spacebar to pause
4400 GOTO 3200                   'get another data cycle
4500 BEEP                        'indicates at end
4600 CLOSE #2                   'close input file
4700 LOCATE 18,1                'so screen doesn't scroll at end

```

PLOTTER.BAS

```

100 'PLOTTER - plots sections, T/S, etc.(for NA-1)
200   DEFLT$="b:"
300 CLS: KEY OFF
400 'SCREEN 3: COLOR 0,2   'NEC APC III using Microsoft GW-Basic
401 'SCREEN 9:PALETTE     'IBM with EGA using QuickBasic or BASICA(DOS 3.3)
402 'SCREEN 1:COLOR 0,2   'IBM with CGA using BASICA(DOS <= 3.2) BEWARE
403 '   of LOCATE
500 PRINT "Plotter      files available:" 'check available data files
600 FILES DEFLT$+"*.dat"
700 INPUT "enter file name[without .dat] ";C$:CLS
800 LOCATE 1,28: PRINT C$
900 B$=DEFLT$+C$+"*.dat"           'complete file name
1000 WINDOW SCREEN (0,0)-(640,400) 'default window
1100 'WINDOW SCREEN (50,200)-(150,400) 'for enlarged T-P plot
1300 LINE(411,21)-(629,179),1,B
1400 LINE(410,20)-(630,180),1,B
1500 FOR Y = 0 TO 100 STEP 10 :FOR P = 0 TO 6000 STEP 1000           'section
1550 YY=3*Y: ZZ=180*P/6000
1600 LINE(0,ZZ)-(YY,180),1,B
1700 NEXT :NEXT
1800 FOR J = 0 TO 3:FOR P = 0 TO 6000 STEP 2000                     'diagnostics
1850 ZZ=200+180*P/6000
1900 LINE(50+150*J,ZZ)-(150+150*J,380),1,
2000 NEXT :NEXT
2100 GOSUB 10000:BEEP           ' get map
2200 LOCATE 1,28:INPUT "rec= ";REC
2300 LOCATE 1,28:PRINT " "
2400 LOCATE 1,28:PRINT C$;REC
3000 OPEN "R",#2,B$,18         'open data file using complete file name=b$
3100 FIELD#2,2 AS ST$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS
   O$,2 AS R$
3200 IF EOF(2) THEN GOTO 4500 'check for end of file, if so quit
3300   GET#2,REC               'get data cycle
3400   DT=CVI(DT$):P=CVI(P$):T=CVI(T$):S=CVI(S$):O=CVI(O$):R=CVI(R$)
3500   ST=CVI(ST$) :LAT=.01*CVI(LAT$):LON=.01*CVI(LON$)
3600   YR=INT(DT/100): MN = DT-100*YR: T=T/1000:S=S/1000+15:O=O/100:R=R/1000
3700   GOSUB 5000             'get colors
3800   GOSUB 6000             'plot
3900   REC = REC+1            'update record number
4000   IF ST>STO THEN LOCATE 1,28:PRINT USING "st=####" ;ST
4100   STO=ST                  'update station number
4200   ZZ$=INKEY$              'check keyboard
4300   IF ZZ$=" " THEN WHILE INKEY$=" ":WEND           ' use spacebar to pause
4400 GOTO 3200                 'get another data cycle
4500 BEEP                      'indicates at end
4600 CLOSE #2                  'close input file
4700 LOCATE 1,28 :PRINT "DONE";
4800 WHILE INKEY$=" ":WEND:LOCATE 18,1:STOP

```

continued

PLOTTER.BAS continued

```

5000 CLA = 1+INT((LON+100)/10) MOD 3          'color for map
5100 CLR = 1                                  'color for section
5200 IF T>5 THEN CLR = 2:IF T>10 THEN CLR=3    '      "
5300 IF T>15 THEN CLR = 4 :IF T>20 THEN CLR = 5 '      "
5400 IF T>25 THEN CLR = 6 :IF T>30 THEN CLR = 7 '      "
5500 RETURN
6000 Y=160-2*LAT: X=590+2*LON
6100 Z= 3*(LAT+10)
6200 PSET(X,Y),CLA                          'map
6300 LINE(Z,180*P/6000)-(Z+1,180*P/6000+1),CLR,BF 'section
6400 PSET(50+4*T,200+P*180/6000),CLA          'T - p
6500 PSET(200+ 50*(S-35),380-5*T),CLA         'T - S
6600 PSET(350+ 20*(R-23),380-10*O),CLA        'O - R
6700 PSET(500+ 50*(S-35),200+P*180/6000),CLA  'S - p
6800 RETURN
10000 'plot MAP of N. Atlantic
10050 MAPFIL$=DEFLT$+"map.fil"
10100 OPEN "r",#1,MAPFIL$,4
10200 FIELD#1, 2 AS X$,2 AS Y$
10300 IF EOF(1) THEN GOTO 11400                'done- end of file
10400      GET#1:X=CVI(X$):Y=CVI (Y$)
10500      Y=CVI(X$):X=CVI(Y$)                'lat and lon
10600      X = X/5+180 :Y=Y/5                  'scaled plot variables
10700      IF (X-XO)*2+(Y-YO)*2>20 THEN GOTO 11000
10800      LINE(410+X,160-Y)-(410+XO,160-YO),1
11000      PSET(410+X,160-Y),1
11100      XO=X:YO=Y
11200      IF INKEY$=" " THEN GOTO 11400        'spacebar to quit
11300 GOTO 10300
11400 CLOSE#1
11500 'GOSUB 12000                            'paint in land masses
11600 RETURN
12000 PAINT(580,100),1                        'optional routine to paint in land
12100 PAINT(450,160),1
12200 PAINT(420, 60),1
12300 PAINT(490, 23),1
12400 PAINT(620, 30),1
12500 PAINT(620, 60),1
12600 PAINT(620, 78),1
12700 PAINT(550, 30),1
12800 PAINT(5

```


AUTO PLOT.BAS

```

100 ' autoplot- plotter+minifile
150 ON ERROR GOTO 25000 'intercepts errors for disk protected
200 DEF$="b:"
300 CLS: KEY OFF
400 'SCREEN 3: COLOR 0,2 'NEC APC III using Microsoft GW-Basic
401 'for screen 3 reduce color # by 8 in 5000ff.
402 SCREEN 9:PALETTE 'IBM with EGA using QuickBasic or BASICA(DOS 3.3)
403 'SCREEN 1:COLOR 0,1 'IBM with CGA using BASICA(DOS <= 3.2) BEWARE
404 ' of LOCATE
500 PRINT "Autoplot plots all files in sequence "
510 PRINT " if program halts because file is protected, insert next
520 PRINT " disk and type any key to continue"
530 WHILE INKEY$="":WEND:CLS
600 DIM C$(40),D$(40) 'array of file names and mnemonics
700 GOSUB 20000 'set up arrays c$,d$
750 N=0 'disk1[1-10],2[11-19],3[20-30],4[31-38]
1000 'WINDOW SCREEN (0,0)-(640,400) 'default window
1020 WINDOW SCREEN (400,0)-(650,190) 'for enlarged map
1100 'WINDOW SCREEN (50,200)-(150,400) 'for enlarged T-P plot
1300 LINE(411,21)-(629,179),1,B
1400 LINE(410,20)-(630,180),1,B
1500 FOR Y = 0 TO 100 STEP 10 :FOR P = 0 TO 6000 STEP 1000 'section
1550 YY=3*Y: ZZ=180*P/6000
1600 LINE(0,ZZ)-(YY,180),1,B
1700 NEXT :NEXT
1800 FOR J = 0 TO 3:FOR P = 0 TO 6000 STEP 2000 'diagnostics
1850 ZZ=200+180*P/6000
1900 LINE(50+150*J,ZZ)-(150+150*J,380),1,B
2000 NEXT :NEXT
2100 GOSUB 10000:BEEP ' get map
2110 N = N+1 ' loop files
2120 C$=D$(N):B$=DEF$+D$(N)+".dat"
2200 REC=1
2400 LOCATE 1,60:PRINT " ":LOCATE 1,60:PRINT C$
3000 OPEN "R",#2,B$,18 'open data file using complete file name=b$
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS
OS,2 AS RS
3200 IF EOF(2) THEN GOTO 4500 'check for end of file, if so quit
3300 GET#2,REC 'get data cycle
3400 DT=CVI(DT$):P=CVI(P$):T=CVI(T$):S=CVI(S$):O=CVI(OS):R=CVI(R$)
3500 ST=CVI(STN$):LAT=.01*CVI(LAT$):LON=.01*CVI(LON$)
3600 YR=INT(DT/100): MN = DT-100*YR: T=T/1000:S=S/1000+15:O=O/100:R=R/1000
3700 IF P>9 THEN GOTO 3900 'select records to keep
3750 GOSUB 5000 'get colors
3800 GOSUB 6000 ' plot
3900 REC = REC+1 'update record number

```

continued

AUTO PLOT.BAS continued

```

4000 IF ST>STO THEN LOCATE 1,46:PRINT USING "st=####";ST
4100 STO=ST 'update station number
4200 ZZ$=INKEY$ 'check keyboard
4300 IF ZZ$=" " THEN WHILE INKEY$=" ":WEND ' use spacebar to pause
4400 GOTO 3200 'get another data cycle
4500 BEEP 'indicates at end
4600 CLOSE #2 'close input file
4700 IF N <38 THEN GOTO 2110
4800 STOP
5000 CLA = 1+INT((LAT+LON+120)/10) MOD 6 'color for map
5100 CLR = 1 'color for section
5200 IF T>5 THEN CLR = 10:IF T>10 THEN CLR=11
5300 IF T>15 THEN CLR = 12 :IF T>20 THEN CLR = 13
5400 IF T>25 THEN CLR = 14 :IF T>30 THEN CLR = 15
5500 RETURN
6000 Y=160-2*LAT: X=590+2*LON
6100 Z= 3*(100+LON)
6200 PSET(X,Y),CLR'WE ASSIGN COLORS ON MAP BY TEMPERATURE CLASS
6300 ' LINE(Z,180*P/6000)-(Z+1,180*P/6000+1),CLR,BF 'section
6400 ' PSET(50+4*T,200+P*180/6000),CLA 'T - p
6500 ' PSET(200+ 50*(S-35),380-5*T),CLA 'T - S
6600 ' PSET(350+ 20*(R-23),380-10*O),CLA 'O - R
6700 ' PSET(500+ 50*(S-35),200+P*180/6000),CLA 'S - p
6800 RETURN
10000 'plot MAP of N. Atlantic
10050 MAPFIL$=DEFLT$+"map.fil"
10100 OPEN "r",#1,MAPFIL$,4
10200 FIELD#1, 2 AS X$,2 AS Y$
10300 IF EOF(1) THEN GOTO 11400 'done- end of file
10400 GET#1:X=CVI(X$):Y=CVI (Y$)
10500 Y=CVI(X$):X=CVI(Y$) 'lat and lon
10600 X = X/5+180 :Y=Y/5 'scaled plot variables
10700 IF (X-XO)*2+(Y-YO)*2>20 THEN GOTO 11000
10800 LINE(410+X,160-Y)-(410+XO,160-YO),1
11000 PSET(410+X,160-Y),1
11100 XO=X:YO=Y
11200 IF INKEY$=" " THEN GOTO 11400 'spacebar to quit
11300 GOTO 10300
11400 CLOSE#1
11500 'GOSUB 12000 'paint in land masses
11600 RETURN
12000 PAINT(580,100),1 'optional routine to paint in land
12100 PAINT(450,160),1
12200 PAINT(420, 60),1
12300 PAINT(490, 23),1
12400 PAINT(620, 30),1
12500 PAINT(620, 60),1

```

continued

AUTO PLOT.BAS continued

```

12600 PAINT(620, 78),1
12700 PAINT(550, 30),1
12800 PAINT(572, 53),1
12900 PAINT(587, 53),1
13000 PAINT(479, 63),1
13100 PAINT(419, 23),1
13200 PAINT(419,131),1
13300 PAINT(419, 31),1
13400 PAINT(449, 23),1
13500 PAINT(462, 70),1
13600 PAINT(582, 46),1
13700 RETURN
20000 C$(1)="AT212"      :D$(1)="bdae"
20100 C$(2)="EN129CTD"  :D$(2)="64w"
20200 C$(3)="OC133CTD"  :D$(3)="52w"
20300 C$(4)="KN104CTD"  :D$(4)="35w"
20400 C$(5)="CF017"     :D$(5)="carib"
20500 C$(6)="AN109"     :D$(6)="beta"
20600 C$(7)="AT215"     :D$(7)="bdaw"
20700 C$(8)="AT233"     :D$(8)="bdas"
20800 C$(9)="AN011"     :D$(9)="57w"
20900 C$(10)="CI009"    :D$(10)="dram"
21000 C$(11)="ERDAN"    :D$(11)="60n"
21100 C$(12)="DIS001"   :D$(12)="46n"
21200 C$(13)="DIS002"   :D$(13)="24n"
21300 C$(14)="DIS003"   :D$(14)="50n"
21400 C$(15)="AN013"    :D$(15)="wtridge"
21500 C$(16)="AN109CTD" :D$(16)="24-36n"
21600 C$(17)="CF016"    :D$(17)="16-40n"
21700 C$(18)="CF022"    :D$(18)="equat"
21800 C$(19)="CF010"    :D$(19)="8s-8n"
21900 C$(20)="ADOHRN"   :D$(20)="dohrn"
22000 C$(21)="BA001"    :D$(21)="baffin"
22100 C$(22)="CF165"    :D$(22)="brazil"
22200 C$(23)="AT229"    :D$(23)="50w"
22300 C$(24)="OC036CTD" :D$(24)="brazil2"
22400 C$(25)="AN007"    :D$(25)="36nold"
22500 C$(26)="AN017"    :D$(26)="eqc"
22600 C$(27)="AN020"    :D$(27)="montbda"
22700 C$(28)="CF028"    :D$(28)="gsslope"
22800 C$(29)="AT231"    :D$(29)="romaine"
22850 C$(30)="GEOSECS"  :D$(30)="geosecs"
22900 C$(31)="OC133CT&" :D$(31)="12nw"
23000 C$(32)="CI012"    :D$(32)="gse"
23100 C$(33)="AT255"    :D$(33)="gsw"
23200 C$(34)="CF040"    :D$(34)="gsm"
23300 C$(35)="CF091"    :D$(35)="eq2"

```

continued

AUTO PLOT.BAS continued

```
23400 C$(36)="DIS"      :D$(36)="32n"
23500 C$(37)="OC078"    :D$(37)="beta2"
23550 C$(38)="AT263"    :D$(38)="med"
23600 RETURN
25000 LOCATE 1,1
25100 IF ERR<>70 THEN PRINT "error # = ";ERR:STOP
25200 PRINT "insert next disk then any key to continue"
25300 WHILE INKEY$="": WEND 'pause until key is struck
25400 LOCATE 1,1
25500 PRINT "
25600 RESUME
```

MINIFILE.BAS

```

100 'MINIFILE  makes special files from all four disks
150 ON ERROR GOTO 25000 'intercepts errors with disk protected
200 DEFLT$="b:"          'default directory
300 CLS: KEY OFF
400 SCREEN 2
500 LOCATE 4,1:PRINT "minifile  takes files from list successively
502 PRINT "      output file goes to disk a: which must not be write protected
504 PRINT "      input disks in b: should be write protected
506 PRINT
510 PRINT "      if program halts because file is protected, insert next
520 PRINT "      disk and type any key to continue"
530 LOCATE 14,1:PRINT      "station      p      lat      lon"
600 DIM C$(40),D$(40)      'array of file names and mnemonics
700 GOSUB 20000              'set up arrays c$,d$
725 COUT$="a:surface.dat"    'or whatever file name you choose
730 N=0                      'disk1[1-10],2[11-19],3[20-30],4[31-38]
750 OPEN "R",#1,COUT$,18
775 FIELD#1,2 AS STN$,2 AS LATM$,2 AS LONM$,2 AS DTM$,2 AS PM$,2 AS TM$,2 AS SM
$,2 AS OM$,2 AS RM$
800 N = N+1                  ' loop files
900 B$=DEFLT$+D$(N)+".dat"
2200 REC=1
2300 LOCATE 11,1:PRINT "
2400 LOCATE 11,1:PRINT B$
3000 OPEN "R",#2,B$,18      'open data file  using complete file name=b$
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS
O$,2 AS R$
3150 LOCATE 20,1:PRINT "
3200 IF EOF(2) THEN GOTO 4600 'check for end of file, if so quit
3300 GET#2,REC              'get data cycle
3400 DT=CVI(DT$):P=CVI(P$):T=CVI(T$):S=CVI(S$):O=CVI(O$):R=CVI(R$)
3500 STN=CVI(STN$):LAT=CVI(LAT$):LON=CVI(LON$)
3550 IF LAT=0 AND LON=0 THEN GOTO 4600
3600 STNT=STN:PT=P: DTT=DT: LATT=LAT/100: LONT=LON/100: TT=T/1000: ST=S/1000+15:
RT=R/1000: OT=O/100      'temporary values for interrupts
3700 IF PT>9 THEN GOTO 3900  'select records to skip
3800 LSET DTM$=MKI$(DT):LSET STNM$=MKI$(STN):LSET RM$=MKI$(R)
3830 LSET PM$=MKI$(P):LSET TM$ = MKI$(T):LSET SM$=MKI$(S):LSET OM$=MKI$(O)
3840 LSET LATM$=MKI$(LAT):LSET LONM$=MKI$(LON)
3850 PUT#1
3860 LOCATE 15,1:PRINT USING " ####      ###.##      ###.##";STN,P,LATT,LONT
3870 LOCATE 20,1            'wait here from errors
3900 REC = REC+1
4200 ZZ$=INKEY$              'check keyboard
4300 IF ZZ$=" " THEN WHILE INKEY$=" ":WEND      ' use spacebar to pause
4400 GOTO 3200                'get another data cycle
4500 BEEP                    'indicates at end
4600 CLOSE #2                'close input file
4700 IF N >39 THEN LOCATE 18,1 : CLOSE#1 : STOP
4800 GOTO 800

```

continued

MINIFILE.BAS continued

```

20000 C$(1)="AT212"      :D$(1)= "bdae"
20100 C$(2)="EN129CTD"   :D$(2)= "64w"
20200 C$(3)="OC133CTD"   :D$(3)= "52w"
20300 C$(4)="KN104CTD"   :D$(4)= "35w"
20400 C$(5)="CF017"      :D$(5)= "carib"
20500 C$(6)="AN109"      :D$(6)= "beta"
20600 C$(7)="AT215"      :D$(7)= "bdaw"
20700 C$(8)="AT233"      :D$(8)= "bdas"
20800 C$(9)="AN011"      :D$(9)= "57w"
20900 C$(10)="CI009"     :D$(10)= "dram"
21000 C$(11)="ERDAN"     :D$(11)= "60n"
21100 C$(12)="DIS001"    :D$(12)= "46n"
21200 C$(13)="DIS002"    :D$(13)= "24n"
21300 C$(14)="DIS003"    :D$(14)= "50n"
21400 C$(15)="AN013"     :D$(15)= "wtridge"
21500 C$(16)="AN109CTD"  :D$(16)= "24-36n"
21600 C$(17)="CF016"     :D$(17)= "16-40n"
21700 C$(18)="CF022"     :D$(18)= "equat"
21800 C$(19)="CF010"     :D$(19)= "8s-8n"
21900 C$(20)="ADOHRN"    :D$(20)= "dohrn"
22000 C$(21)="BA001"     :D$(21)= "baffin"
22100 C$(22)="CF165"     :D$(22)= "brazil"
22200 C$(23)="AT229"     :D$(23)= "50w"
22300 C$(24)="OC036CTD"  :D$(24)= "brazil2"
22400 C$(25)="AN007"     :D$(25)= "36nold"
22500 C$(26)="AN017"     :D$(26)= "eqc"
22600 C$(27)="AN020"     :D$(27)= "montbda"
22700 C$(28)="CF028"     :D$(28)= "gsslope"
22800 C$(29)="AT231"     :D$(29)= "romaine"
22850 C$(30)="GEOSECS"   :D$(30)= "geosecs"
22900 C$(31)="OC133CT&" :D$(31)= "12nw"
23000 C$(32)="CI012"     :D$(32)= "gse"
23100 C$(33)="AT255"     :D$(33)= "gsw"
23200 C$(34)="CF040"     :D$(34)= "gsm"
23300 C$(35)="CF091"     :D$(35)= "eq2"
23350 C$(36)="DIS"       :D$(36)= "32n"
23400 C$(37)="OC078"     :D$(37)= "beta2"
23500 C$(38)="AT263"     :D$(38)= "med"
23600 RETURN
25000 LOCATE 1,1
25100 IF ERR<>70 THEN PRINT "error #=" ;ERR:STOP
25110 IF ERR<>71 THEN PRINT "check output file specification":STOP 'check 725
25200 PRINT "insert new disk, then any key "
25300 WHILE INKEY$="" :WEND 'pause until strike key
25400 LOCATE 1,1:PRINT "
25500 RESUME

```

FASTSCAN.BAS

```

100 ' fastscan a version of plotter - plots planview with keys
200 DEFLT$="b:" 'default directory
300 CLS: KEY OFF
350 KEY(11) ON:KEY(12) ON:KEY(13) ON:KEY(14) ON 'machine dependent!!
370 NUM= 4000
375 DIM X%(NUM),Y%(NUM),T%(NUM),INDEX$(10,1000),N$(10) 'save as integers
380 INUM=0
400 'SCREEN 3: COLOR 0,2 'NEC APC III using Microsoft GW-Basic
401 'SCREEN 9:PALETTE 'IBM with EGA using QuickBasic or BASICA(DOS 3.3)
402 SCREEN 1:COLOR 0,1 'IBM with CGA using BASICA(DOS <= 3.2)
500 PRINT "Fastscan files available:
600 FILES DEFLT$+"*.dat"
700 INPUT "enter file name[without .dat] ";C$:CLS
800 LOCATE 1,1:PRINT C$
900 B$=DEFLT$+C$+".dat" 'complete file name
1000 'WINDOW SCREEN (0,0)-(640,400) 'default window
1150 'WINDOW SCREEN (50,200)-(150,400) 'for enlarged T-P plot
1160 WINDOW SCREEN (400,-1) -(650,198) 'for enlarged map
1200 T9=15 : T9INT=1000*T9 :DELT=.25 :GOSUB 15000 'sacles for contours
1300 LINE(411,21)-(629,179),1,B
1400 LINE(410,20)-(630,180),1,B
1500 FOR Y = 0 TO 100 STEP 10 :FOR P = 0 TO 6000 STEP 1000
1550 YY=3*Y: ZZ=180*P/6000
1600 LINE(0,ZZ)-(YY,180),1,B
1700 NEXT :NEXT
1800 FOR J = 0 TO 3:FOR P = 0 TO 6000 STEP 2000
1850 ZZ=200+180*P/6000
1900 LINE(50+150*J,ZZ)-(150+150*J,380),1,B
2000 NEXT :NEXT
2100 GOSUB 10000:BEEP ' get map
2200 REC=1
2300 LOCATE 1,1:PRINT "
2400 LOCATE 1,5:PRINT C$
3000 OPEN "R",#2,B$,18 'open data file using complete file name=b$
3100 FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS
O$,2 AS R$
3200 IF EOF(2) THEN GOTO 4500 'check for end of file, if so quit
3300 GET#2,REC 'get data cycle
3400 DT=CVI(DT$):P=CVI(P$):T=CVI(T$):S=CVI(S$):O=CVI(O$):R=CVI(R$)
3500 ST=CVI(STN$):LAT=CVI(LAT$):LON=CVI(LON$) 'note not divided by 100
3510 TINT=T 'keep integer temps to speed up plotting&scaling
3600 YR=INT(DT/100): MN = DT-100*YR: T=T/1000:S=S/1000+15:O=O/100:R=R/1000
3700 GOSUB 5000 'get colors
3800 GOSUB 6000 'plot also specify arrays
3810 IF INUM=NUM THEN GOTO 4600 ' make sure don't overflow arrays
3900 REC = REC+1

```

continued

FASTSCAN.BAS continued

```

4200     ZZ$=INKEY$                                'check keyboard
4300     IF ZZ$=" " THEN WHILE INKEY$=" ":WEND      'use spacebar to pause
4400 GOTO 3200                                     'get another data cycle
4500 BEEP                                         'indicates at end
4600 CLOSE #2                                    'close input file
4700 'now have data internally ' put in new loop to use cursor keys
4800 GOTO 30000
5000 IF TINT<T9INT THEN CLR=3 ELSE CLR=2         'integer temps=TINT
5100 RETURN
6000 Y=160-2*LAT/100: X=590+2*LON/100
6010 ' note change here need to divide lat,lon by 100 to plot
6100 INUM=INUM+1:X%(INUM)=LON:Y%(INUM)=LAT:T%(INUM)=TINT 'set arrays
6200 II=INT(LAT/1000)+2                          'set up index for coarse sorting
6300 N%(II)=N%(II)+1
6400 INDEX%(II,N%(II))=INUM
6500 PSET (590+2*X%(INUM)/100,160-2*Y%(INUM)/100),CLR 'map only
6800 RETURN
10000 'plot MAP of N. Atlantic
10050 MAPFIL$=DEFAULT$+"map.fil"
10100 OPEN "r",#1,MAPFIL$,4
10200 FIELD#1, 2 AS X$,2 AS Y$
10300 IF EOF(1) THEN GOTO 11400                  'done- end of file
10400     GET#1:X=CVI(X$):Y=CVI (Y$)
10500     Y=CVI(X$):X=CVI(Y$)                    'lat and lon
10600     X = X/5+180 :Y=Y/5                     'scaled plot variables
10700     IF (X-XO)*2+(Y-YO)*2>20 THEN GOTO 11000
10800         LINE(410+X,160-Y)-(410+XO,160-YO),1
11000     PSET(410+X,160-Y),1
11100     XO=X:YO=Y
11200     IF INKEY$=" " THEN GOTO 11400          'spacebar to quit
11300 GOTO 10300
11400 CLOSE#1
11500 'GOSUB 12000                                'paint in land masses
11600 RETURN
12000 PAINT(580,100),1
12100 PAINT(450,160),1
12200 PAINT(420, 60),1
12300 PAINT(490, 23),1
12400 PAINT(620, 30),1
12500 PAINT(620, 60),1
12600 PAINT(620, 78),1
12700 PAINT(550, 30),1
12800 PAINT(572, 53),1
12900 PAINT(587, 53),1
13000 PAINT(479, 63),1
13100 PAINT(419, 23),1
13200 PAINT(419,131),1
13300 PAINT(419, 31),1

```

continued

FASTSCAN.BAS continued

```

13400 PAINT(449, 23),1
13500 PAINT(462, 70),1
13600 PAINT(582, 46),1
13700 RETURN
15000 'does plot at bottom of screen for fastscan
15100 LOCATE 25,8:PRINT USING " <###.## <= ";T9;
15200 LINE (400,190)-(420,200),3,BF
15300 LINE (520,190)-(540,200),2,BF
15400 ICOUNT=0
15500 RETURN
30000 GOSUB 15000 'update scale display
30100 II=0
30200 LOCATE 24,1:PRINT " use cursors then type g for update";
30300 ON KEY(11) GOSUB 32000 'up
30400 ON KEY(14) GOSUB 33000 'down
30410 QS=INKEY$
30420 IF QS="g" THEN GOTO 30600
30500 GOTO 30100
30600 LOCATE 24,1:PRINT " ";
30610 LINE (400,Y0)-(405,Y10),0,BF
30620 Y=160-2*(10*(II-.5)):Y1=160-2*(10*(II-1.5))
30625 LINE (400,Y)-(405,Y1),6,BF
30630 LINE (400,Y)-(405,Y1),6,BF
30640 Y0=Y:Y10=Y1
30650 II=II+1 : JJ=0 : IF II>10 THEN GOTO 30100 'start over
30700 JJ=JJ+1 : IF JJ>N%(II) THEN GOTO 30600
30750 K=INDEX%(II,JJ)
30800 TINT=T%(K):GOSUB 5000 'get color
30900 PSET (590+2*X%(K)/100,160-2*Y%(K)/100),CLR
31000 QS=INKEY$
31100 IF QS="s" THEN WHILE INKEY$="":WEND
31200 GOTO 30700
32000 'key up
32100 T9=T9+DELT : T9INT=1000*T9
32200 LOCATE 24,1:PRINT " ";
32300 GOSUB 15000
32400 RETURN
33000 'key down
33100 T9=T9-DELT : T9INT=1000*T9
33200 LOCATE 24,1:PRINT " ";
33300 GOSUB 15000
33400 RETURN

```

POTEMP.BAS

```

40000 DIM A(4,4,4)
40020 A(1,0,0)=3.6504E-05
40030 A(1,0,1)=8.3198E-06
40040 A(1,0,2)=-5.4065E-08
40050 A(1,0,3)=4.0274E-10
40060 A(1,1,0)=1.7439E-06
40070 A(1,1,1)=-2.9778E-08
40080 A(2,1,0)=-4.1057E-11
40090 A(2,0,0)=8.930899E-09
40100 A(2,0,1)=-3.1628E-10
40110 A(2,0,2)=2.1987E-12
40120 A(3,0,0)=-1.6056E-13
40130 A(3,0,1)=5.0484E-15
40220 AZ(0)=999.842594#
40230 AZ(1)=6.793952E-02
40240 AZ(2)=-9.09529E-03
40250 AZ(3)=1.001685E-04
40260 AZ(4)=-1.120083E-06
40270 AZ(5)=6.536332E-09
40320 B(0)=.824493:B(1)=-.0040899:B(2)=7.6438E-05
40330 B(3)=-8.2467E-07:B(4)=5.3875E-09
40340 C(0)=-5.72466E-03:C(1)=1.0227E-04
40350 C(2)=-1.6456E-06:D0=4.8314E-04
40360 RETURN
41000 'sub for tpot
41150 FOR I = 1 TO 3:FOR J=0 TO 1: FOR K = 0 TO 3
41160 SUM = SUM + A(I,J,K)*P*I*(S-35)*J*T*K
41170 NEXT: NEXT: NEXT
41180 TPOT=T-SUM
41190 SUM = 0
41200 RETURN
42000 'sub for sigma t or theta
42080 RW=0
42090 FOR I = 0 TO 5
42100 RW=RW+AZ(I)*(TC*I)
42110 NEXT
42160 BB = 0
42170 FOR I = 0 TO 4:BB=BB+B(I)*(TC*I):NEXT
42180 CC=0
42190 FOR I = 0 TO 2:CC=CC+C(I)*(TC*I):NEXT
42200 R = RW+BB*S+CC*(S*(3/2))+D0*(S^2)
42220 RETURN
50000 'percent saturation of oxygen in ml/l from Weiss,DSR 17, 721
50100 A1=-173.4292:A2=249.6339:A3=143.3483:A4=-21.8492
50200 B1=-.033096:B2=.014259:B3=-.0017
50300 T2=(T+273.15)/100
50400 LNC=A1+A2/T2+A3*LOG(T2)+A4*T2+S*(B1+B2*T2+B3*T2*T2)
50410 CONC=EXP(LNC): PERCENT=O/CONC
50500 RETURN

```

Appendix 3. Directory of the Atlantic Disks

Volume in drive B is NA-1
Directory of B:*

BDAE	DAT	10080	10-14-87	9:59a
64W	DAT	45090	10-05-87	7:53a
52W	DAT	47988	10-05-87	8:13a
35W	DAT	50184	10-05-87	8:21a
CARIB	DAT	29268	10-27-88	8:34a
BETA	DAT	18882	10-05-87	8:33a
BDAW	DAT	23922	10-15-87	7:28a
BDAS	DAT	10764	10-15-87	7:30a
57W	DAT	13572	10-15-87	7:52a
DRAM	DAT	85158	10-15-87	7:43a
MAP	FIL	6760	9-25-87	11:52a
MAKER	BAS	1490	12-10-87	10:56a
READER	BAS	1416	11-01-88	1:11p
PLOTTER	BAS	4096	11-01-88	2:05p
14 File(s)			6144 bytes free	

Volume in drive B is NA-2
Directory of B:*

READER	BAS	1416	11-01-88	1:11p
PLOTTER	BAS	5828	11-01-88	1:08p
MAP	FIL	6760	9-25-87	11:52a
24N	DAT	15876	10-26-88	9:23a
8S-8N	DAT	31158	10-04-87	8:03a
EQUAT	DAT	19440	10-04-87	8:07a
16-40N	DAT	37728	10-27-88	8:33a
24-36N	DAT	98928	10-04-87	8:29a
46N	DAT	14994	10-26-88	9:23a
50N	DAT	29664	10-26-88	9:24a
WTRIDGE	DAT	8298	10-04-87	8:32a
60N	DAT	83898	10-04-87	8:56a
12 File(s)			4096 bytes free	

Directory of the Atlantic Disks continued

Volume in drive B is NA-3
Directory of B:•

MAP	FIL	6760	9-25-87	11:52a
DOHRN	DAT	75492	10-26-88	9:21a
BRAZIL	DAT	48168	10-26-88	9:24a
50W	DAT	23490	10-26-88	9:22a
BRAZIL2	DAT	14454	10-12-87	8:23a
36NOLD	DAT	29502	10-26-88	9:20a
EQC	DAT	21384	10-27-88	8:29a
MONTBDA	DAT	8588	10-12-87	8:34a
ROMAINE	DAT	4068	10-26-88	9:21a
BAFFIN	DAT	30474	10-12-87	8:42a
GSSLOPE	DAT	21456	10-12-87	8:47a
GEOSECS	DAT	45396	11-16-87	9:52a
READER	BAS	1416	11-01-88	1:11p
PLOTTER	BAS	4096	11-01-88	2:05p
PLOTTER1	BAS	5828	11-01-88	1:08p
PLOTTER3	BAS	5835	11-01-88	9:35a
PLOTTER9	BAS	5851	11-01-88	1:43p
17 File(s)			4096 bytes free	

Volume in drive B is NA-4
Directory of B:•

GSE	DAT	43578	10-28-88	9:21a
GSM	DAT	46062	10-28-88	9:21a
12NW	DAT	13266	10-12-87	10:25a
GSW	DAT	43020	10-28-88	9:22a
EQ2	DAT	85590	11-02-87	12:26p
BETA2	DAT	14886	10-16-87	4:34p
32N	DAT	5472	11-02-87	12:40p
MAP	FIL	6760	9-25-87	11:52a
MED	DAT	792	11-24-87	5:25p
POTEMP	BAS	1835	12-10-87	4:25p
PLOTTER	BAS	4096	11-01-88	2:05p
READER	BAS	1416	11-01-88	1:11p
AUTOPILOT	BAS	6549	11-01-88	1:41p
FASTSCAN	BAS	5524	11-01-88	12:31p
MINIFILE	BAS	4449	11-01-88	1:55p
SURFACE	DAT	48582	10-14-87	4:41p
P3000	DAT	16020	10-16-87	8:32a
17 File(s)			7168 bytes free	

Acknowledgements

Gathering and formulating this "atlas on floppy disks" was supported by the Office of Naval Research under contract Number N00014-84-C-0134, NR 083-400 (JRL) and the National Science Foundation through grant Number OCE86-13810 (HMS).

References

- Armi, L. and H. Stommel, 1983. Four views of a portion of the North Atlantic subtropical gyre. Journal of Physical Oceanography, 13, 828-857.
- Bryden, H. L., 1973. New polynomials for thermal expansion, adiabatic temperature gradient and potential temperature of sea water. Deep-Sea Research, 20, 401-408.
- Fofonoff, N. P. and R. C. Millard, Jr., 1983. Algorithms for computation of fundamental properties of seawater. UNESCO Technical Papers in Marine Science No. 44, 53 pp.
- Pivar, M., E. Fredkin and H. Stommel, 1963. Computer-compiles oceanographic atlas: an experiment in man-machine interaction. Proceedings of the National Academy of Sciences, U.S.A., 50, 396-398.
- Saunders, P. M., 1986. The accuracy of measurement of salinity, oxygen and temperature in the deep ocean. Journal of Physical Oceanography, 16, 189-195.

Table I. Identification of Cruise Data Files

N	NODC C\$(N)	MNEMONIC D\$(N)	DESCRIPTION	DISK
1	AT212	bdae	Bermuda-east	NA-1
2	EN129CTD	64w		
3	OC133CTD	52w		
4	KN104CTD	35w		
5*	CF017	carib	Caribbean	
6	AN109	beta	Beta-spiral	
7	AT215	bdaw	Bermuda west	
8	AT233	bdas	Bermuda south	
9	AN011	57w		
10	AN009	dram	Drambuie	
11	ERDAN	60n	at and about 60°N	NA-2
12*	DIS001	46n	Newfoundland to Iceland	
13*	DIS002	24n	old section	
14*	DIS003	50n	at and about 50°N	
15	AN013	wtridge	Wyville Thomson Ridge	
16	AN109CTD	24-36n	two new sections	
17*	CF016	16-40n		
18	CF022	equat	0° latitude	
19	CF010	8s-8n	two sections	
20*	ADOHRN	dohrn	off Greenland	NA-3
21**	BA001	baffin	off Newfoundland	
22*	CF165	brazil	coast of Brazil	
23*	AT229	50w		
24	OC036CTD	brazil2	another coast of Brazil	
25*	AN007	36nold	old section	
26*	AN017	eqc	across equator	
27	AN020	montbda	Montauk - Bermuda	
28	CF028	gsslope	Slope water inside Gulf Stream	
29*	AT231	romaine	Cape Romaine	
30	GEOSECS	geosecs		
31	OC133CT&	12nw	short section near 12°N	NA-4
32*	CI012	gse	Gulf Stream 60, east	
33*	AT255	gsw	Gulf Stream 60, west	
34*	CF040	gsm	Gulf Stream 60, middle	
35	CF091	eq2	across equator	
36	DIS	32n	partial section at 32N (joins AT212 and AT215)	
37	OC078	beta2	alternate beta	
38	AT263	med	Mediterranean (2 stations)	

* NODC station numbers corrected by us.

** NODC station numbers missing.

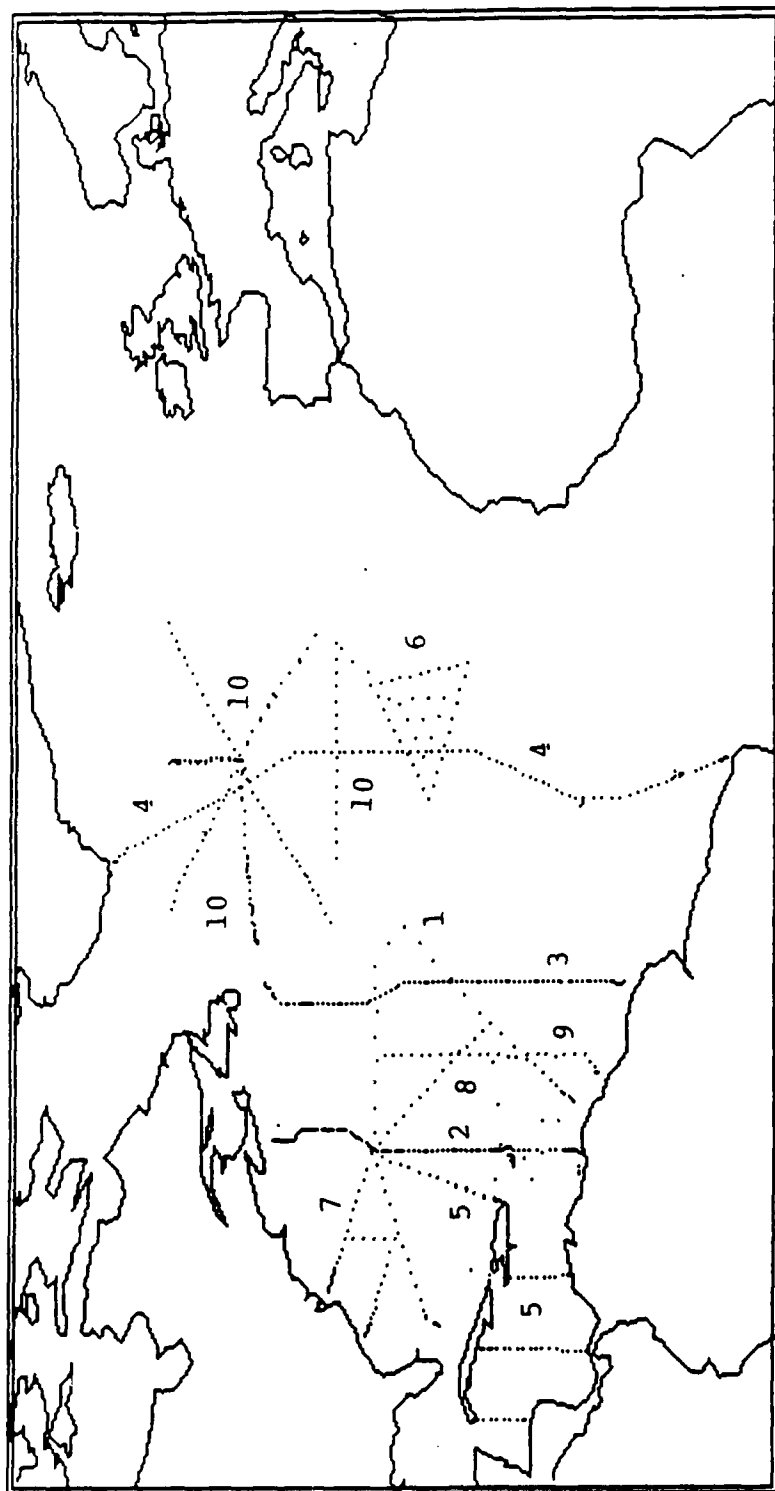


Figure 1. Positions of stations on Disk 1

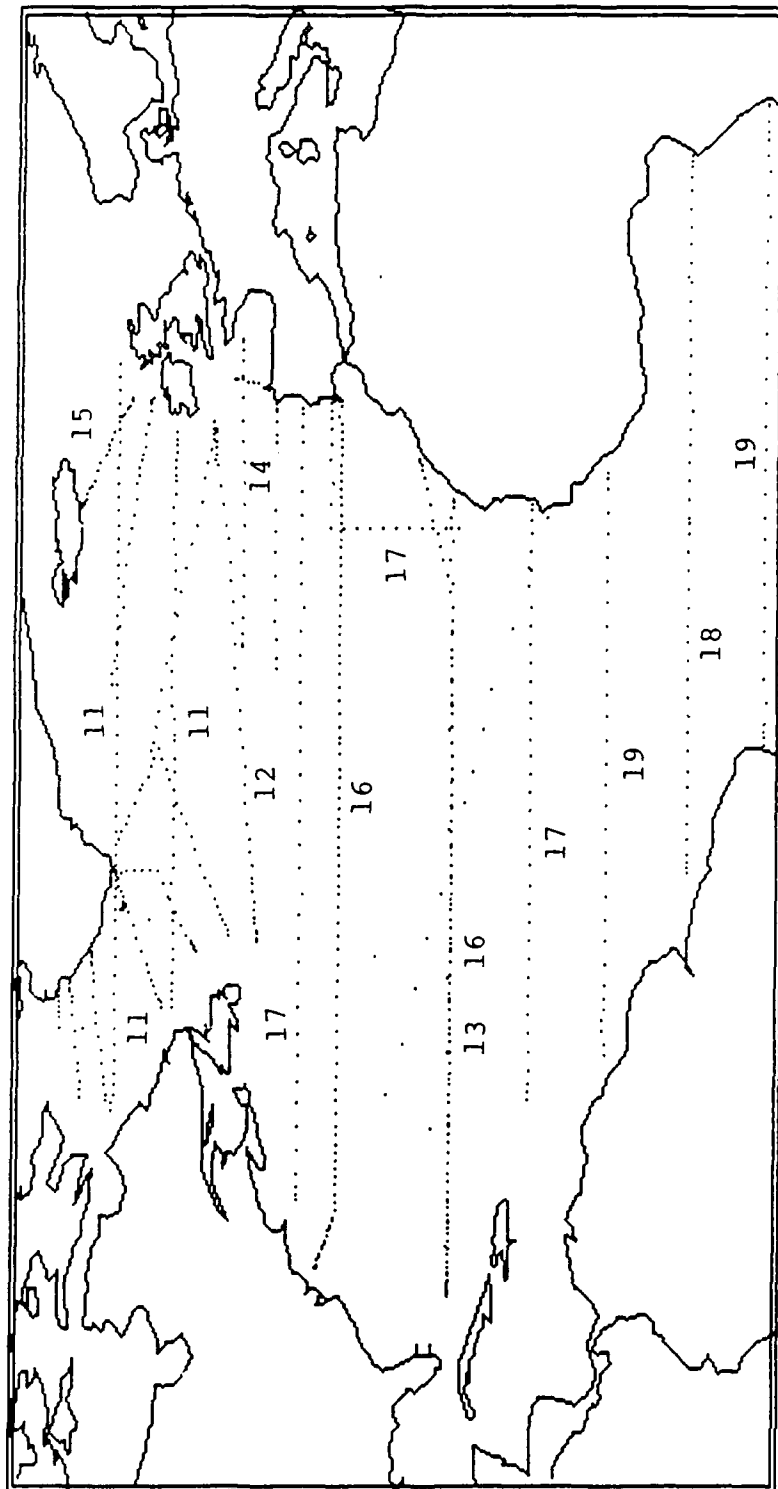


Figure 2. Positions of stations on Disk 2

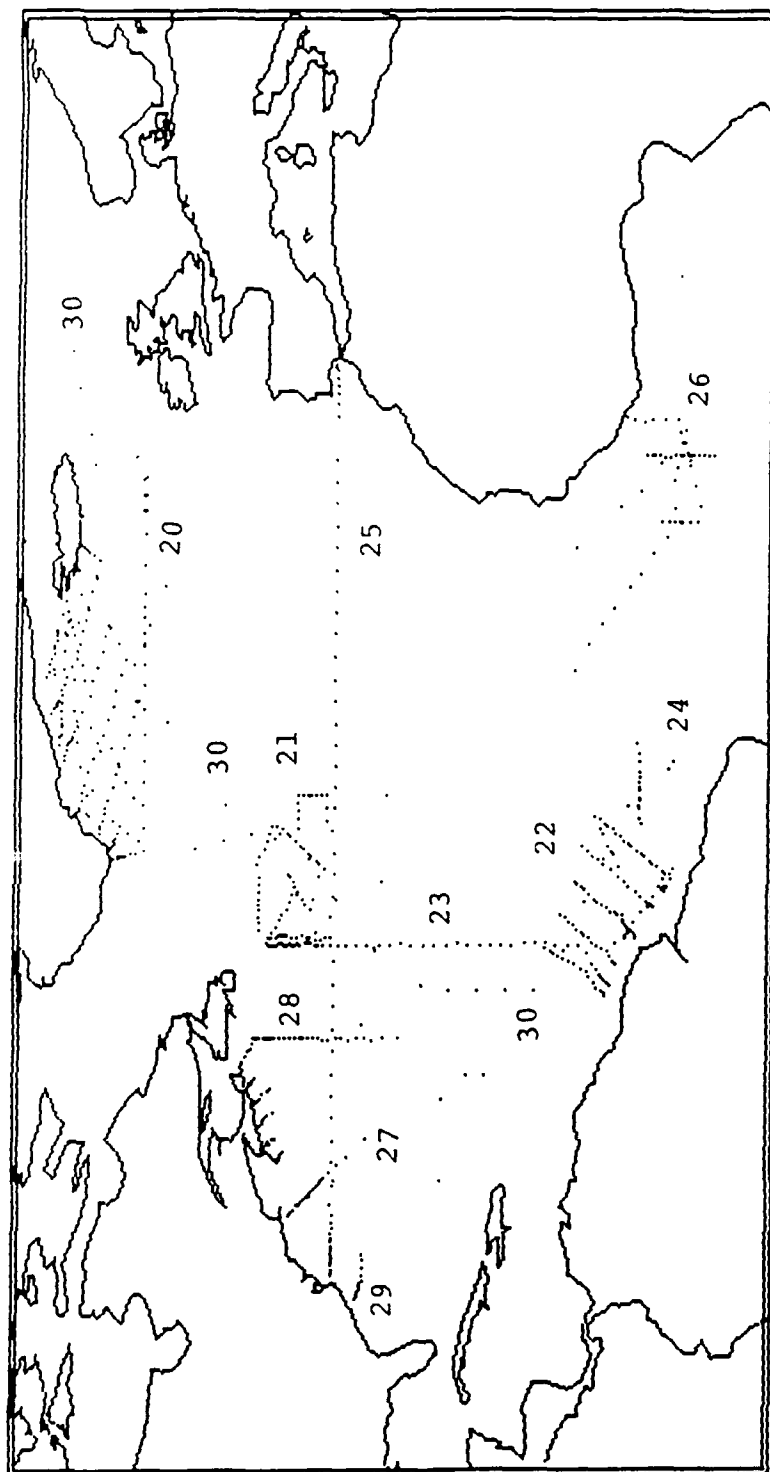


Figure 3. Positions of stations on Disk 3

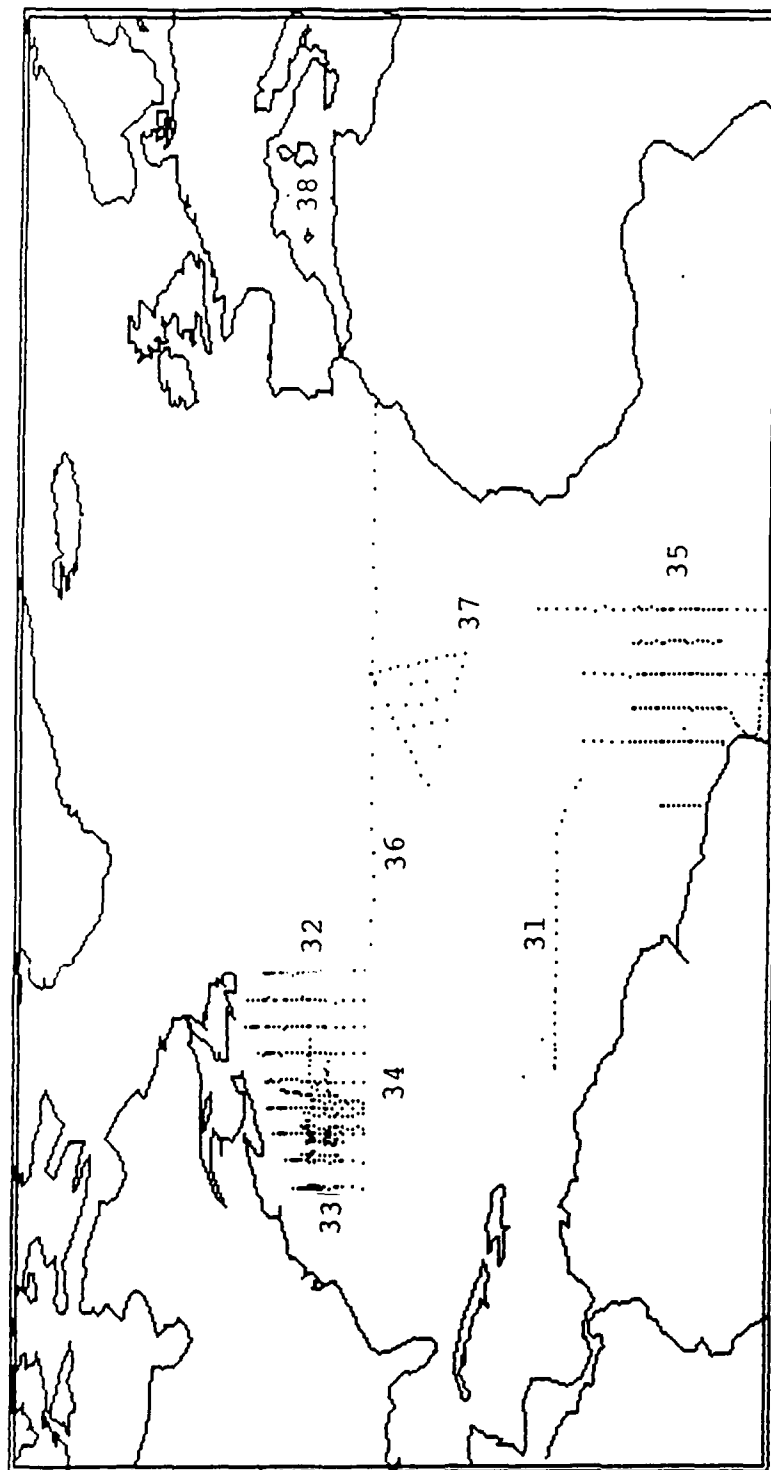


Figure 4. Positions of stations on Disk 4

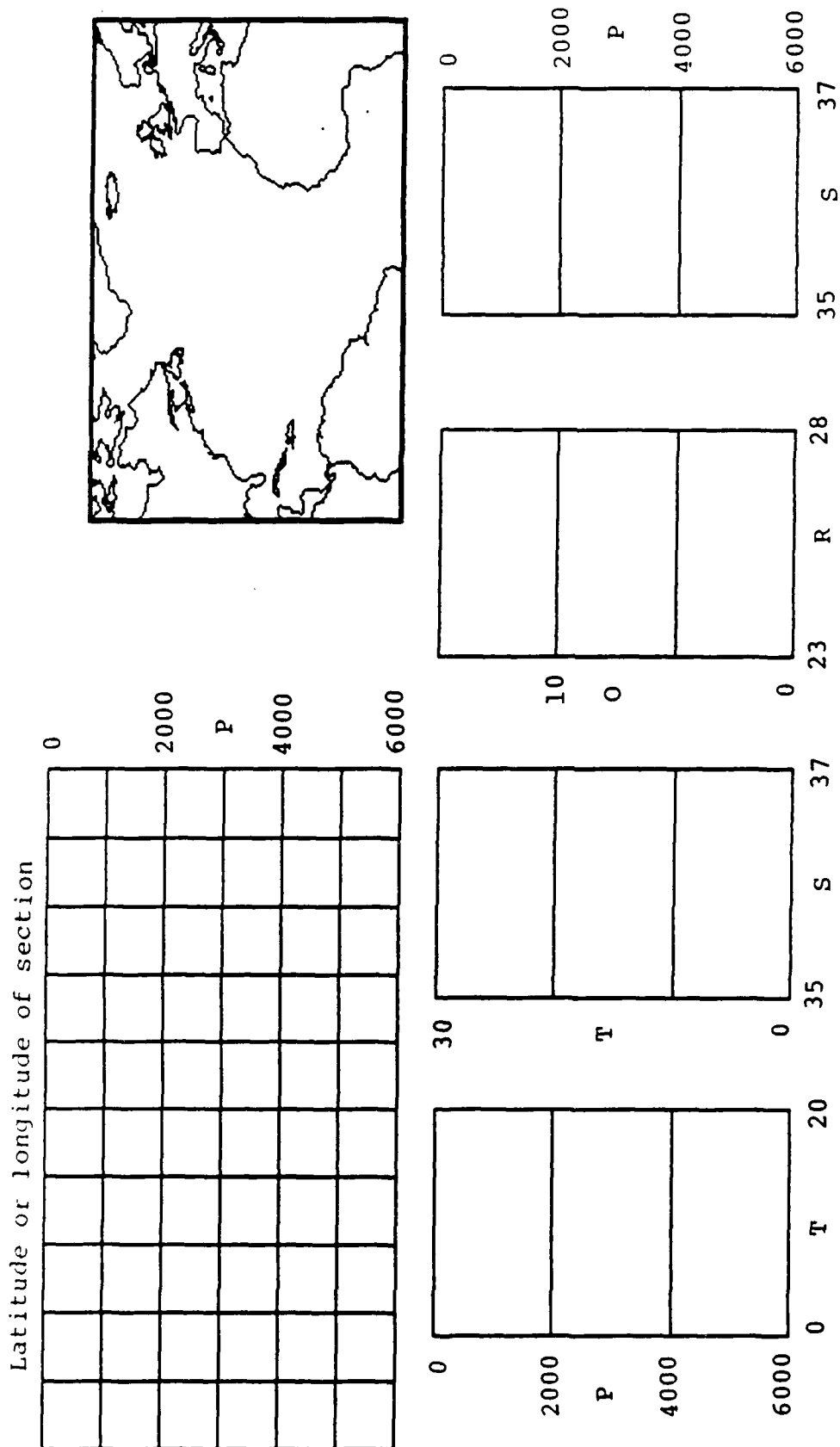


Figure 5. Sketch of screen for PLOTTER

DOCUMENT LIBRARY

August 9, 1988

Distribution List for Technical Report Exchange

Attn: Stella Sanchez-Wade
Documents Section
Scripps Institution of Oceanography
Library, Mail Code C-075C
La Jolla, CA 92093

Hancock Library of Biology &
Oceanography
Alan Hancock Laboratory
University of Southern California
University Park
Los Angeles, CA 90089-0371

Gifts & Exchanges
Library
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS, B2Y 4A2, CANADA

Office of the International
Ice Patrol
c/o Coast Guard R & D Center
Avery Point
Groton, CT 06340

Library
Physical Oceanographic Laboratory
Nova University
8000 N. Ocean Drive
Dania, FL 33304

NOAA/EDIS Miami Library Center
4301 Rickenbacker Causeway
Miami, FL 33149

Library
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, GA 31416

Institute of Geophysics
University of Hawaii
Library Room 252
2525 Correa Road
Honolulu, HI 96822

Library
Chesapeake Bay Institute
4800 Atwell Road
Shady Side, MD 20876

MIT Libraries
Serial Journal Room 14E-210
Cambridge, MA 02139

Director, Ralph M. Parsons Laboratory
Room 48-311
MIT
Cambridge, MA 02139

Marine Resources Information Center
Building E38-320
MIT
Cambridge, MA 02139

Library
Lamont-Doherty Geological
Observatory
Columbia University
Palisades, NY 10964

Library
Serials Department
Oregon State University
Corvallis, OR 97331

Pell Marine Science Library
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882

Working Collection
Texas A&M University
Dept. of Oceanography
College Station, TX 77843

Library
Virginia Institute of Marine Science
Gloucester Point, VA 23062

Fisheries-Oceanography Library
151 Oceanography Teaching Bldg.
University of Washington
Seattle, WA 98195

Library
R.S.M.A.S.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

Maury Oceanographic Library
Naval Oceanographic Office
Bay St. Louis
NSTL, MS 39522-5001

Marine Sciences Collection
Mayaguez Campus Library
University of Puerto Rico
Mayaguez, Puerto Rico 00708

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-88-59	2.	3. Recipient's Accession No.
4. Title and Subtitle Exploring the North Atlantic Ocean on Floppy Disks		5. Report Date December 1988	
7. Author(s) James R. Luyten and Henry M. Stommel		8. Performing Organization Rept. No. WHOI-88-59	
9. Performing Organization Name and Address The Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543		10. Project/Task/Work Unit No.	
		11. Contract(C) or Grant(G) No. (C) N00014-84-C-0134 (G) OCE 86-13810	
12. Sponsoring Organization Name and Address Office of Naval Research, 800 North Quincy Street, Arlington, VA 22217-5000; National Science Foundation, Washington, DC 20550		13. Type of Report & Period Covered Technical Report	
		14.	
15. Supplementary Notes This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-88-59.			
16. Abstract (Limit: 200 words) A selection of hydrographic station data in the Atlantic between 8°S and 70°N is packed on four 5 1/4" floppy disks. Sample utility programs for reading and plotting the data are also on the disks. We present this computer atlas in preliminary form for use by students and professionals, in the belief that easy access to this valuable historical data will be educational and stimulating. Criticism and comment are welcome.			
17. Document Analysis a. Descriptors 1. atlas 2. North Atlantic 3. hydrography b. Identifiers/Open-Ended Terms c. COSATI Field/Group			
18. Availability Statement Approved for publication; distribution unlimited.		19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 65
		20. Security Class (This Page)	22. Price